Staff Report of the

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

AMENDMENTS
TO
THE WATER QUALITY CONTROL PLAN FOR THE SACRAMENTO RIVER AND SAN JOAQUIN RIVER BASINS

FOR

THE CONTROL OF SALT AND BORON DISCHARGES INTO THE SAN JOAQUIN RIVER

APPENDIX 2: METHODS FOR REDUCING SALT AND BORON CONCENTRATIONS IN THE LOWER SAN JOAQUIN RIVER

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September 2003
Peer Review Draft

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September 2003
Peer Review Draft

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APPENDIX 2: METHODS OF REDUCING SALINITY AND BORON IN THE LOWER SAN JOAQUIN RIVER

There is no single set of implementation practices or technology that will ensure that the water quality objectives for salt and boron will be met. Salt and boron water quality improvement in the LSJR can be achieved through one or more of the following methods:

I) Reducing salt and boron loads imported to the LSJR watershed in supply water
II) Increasing the assimilative capacity of the LSJR by providing dilution flow
III) Reducing salt and boron loading from point and/or nonpoint sources
IV) Increasing the amount of salt exported from the LSJR watershed, including through re-operation of drainage and real-time water quality management or through the use of an out-of-valley drain

Technical groups for the San Joaquin Valley Drainage Program, CALFED and other efforts investigating the salinity problem have identified a number of practices that may be effective in reducing salt levels in the river. These practices are summarized below. Salinity management practices must be site-specific because the salt generating capacity and drainage needs vary throughout the LSJR watershed due to differences in soils, supply water quality, and drainage and irrigation technology.

I. REDUCING SALT AND BORON LOADS IMPORTED TO THE LSJR WATERSHED IN SUPPLY WATER

1. Improve Quality of Supply Water (Delta)

Improving the quality of water supplies in the LSJR watershed would result in lower salt loads in agricultural, wetland, and municipal discharges. There are several proposals for reducing salt levels in water pumped from the Delta. They include through-Delta conveyance, relocation of drainage from the Delta islands, and South Delta and Delta Region circulation barriers.

Approximately 500 thousand tons of salt per year are currently imported to the LSJR Basin via the Delta Mendota Canal (DMC). All of this salt is stored in soils and groundwater in the basin or discharged to the LSJR. A fifty percent reduction in EC in the DMC would result in reduced import of 250 thousand tons per year. Currently, the average annual salt load discharged from the basin is approximately one million tons per year, so a 50 percent reduction in imported salt loads represents 25 percent of the total load currently being exported.

Status: CALFED and others are evaluating Delta alternatives that could improve the quality of water for water supplies.

II. INCREASING THE ASSIMILATIVE CAPACITY OF THE LSJR BY PROVIDING DILUTION FLOW

1. INCREASING SAN JOAQUIN RIVER FLOWS

Increasing instream flow in the LSJR would provide dilution and mixing options. Additional or existing on-stream or off-stream storage could be used to provide more instream flows.

For example, more releases of water from Friant Dam and east side tributary reservoirs to the LSJR, and recirculation of Delta Mendota Canal water back to the LSJR via Newman wasteway or other channels could supplement flow and provide benefits to multiple LSJR beneficial uses.

Institutional factors, such as the Bay-Delta hearings, the Vernalis Adapted Management Plan, pending laws suits, and FERC rulings affect LSJR water flow. Climatic factors complicate management of the LSJR system and limit flow during dryer years.

Status: Flows in the LSJR continue to vary widely due to factors beyond the control of the Regional Board.

III. REDUCING SALT AND BORON LOADING FROM POINT AND/OR NONPOINT SOURCES

1. Reduced Water Use (Water Conservation)

Water conservation management is the use of improved irrigation methods, such as sprinklers and drip irrigation.

This method reduces the volume of water that must be: imported into the basin; pumped from the LSJR; or pumped from groundwater. Reduction in imported salts can have a large long-term positive impact on water quality. Reduced water application rates will result in less mobilization of in situ salts and a reduction in the amount of imported salt. High conservation rates reduces the volume of water that moves below the root zone as deep percolation and can result in buildup of salts in soils, shallow groundwater, and/or deep groundwater.

Status: the magnitude of positive impact depends on how much water conservation is still feasible -- many areas have already reached high levels of conservation, applying water sufficient only to provide minimum leaching requirement. The magnitude of positive impact also depends what is done with conserved water. Methods that reduce subsurface flow should be more effective in reducing agricultural salts discharge to the LSJR than those that reduce surface drainage.

2. Drainage Recirculation (Tailwater Recovery)

Recirculation is collection and reuse of tailwater to irrigate crops at the field, water district or regional level.

This basic recirculation approach allows for more efficient use of water, particularly when used in conjunction with Water Conservation methods. Use of tailwater recovery systems to reduce or eliminate tailwater discharges may in some cases significantly reduce the flow and increase salt and boron concentrations in receiving waters, because such tailwater systems do not reduce tilewater, which typically is much higher in salts (including boron) than tail water.

Status: drainage recirculation on the farm and district level is commonly used in many parts of the valley. Discharge salt concentration will likely increase as tailwater is recirculated.

3. Sequential Reuse & Volume Reduction

Sequential reuse is the multiple use of irrigation water on progressively salt tolerant plants in order to concentrate and reduce volumes of saline water.

Particularly if combined with ponds and water treatment methods, this approach will help reduce instantaneous peak loads of salt to the LSJR. But unless combined with salt disposal, this method is only a short-term remedy for salt loading to the LSJR because salts are still imported to and generated within the basin. Without consideration of where salt goes in the system, this method can lead to long-term degradation (salinization) of soils and groundwater. Groundwater degradation, in turn, will lead to increased long-term salt loading to the LSJR.

Status: the current water quality regime in the LSJR is a de facto form of sequential reuse where agricultural discharges higher in the watershed become the supply water for more salt tolerant crops (by necessity) further downstream. A few projects using intensive sequential reuse exist on farms in the Tulare Lake and Grasslands Basins. Discharge salt concentration will likely increase as tailwater is reused.

4. Evaporation Ponds

Ponds would be used in this method to evapoconcentrate salts and reduce drainage water volumes.

This method would be most effective combined with initial reduction in volume and concentration of salts using drainage reduction, reuse, and volume reduction methods. Potential adverse impacts to groundwater and wildlife must be addressed. Suitability of use must be evaluated on a local level. Unless combined with salt disposal, this method is only a short-term remedy to salt loading to the LSJR.

Status: evaporation ponds are currently used in Tulare Basin, but are not commonly used in the LSJR Basin.

5. Water Treatment

Treatment methods, such as reverse osmosis and ion exchange, could be used to remove salt and boron as well as trace elements.

Salts removed through these methods would need to be salt disposed, used, or stored. Concentration of drainage water by reuse and separation tile and tail water will result in less volume to treat.

Status: water treatment systems are not currently in use except in experimental form to remove salt or boron from agricultural drainage in the LSJR basin. Disposal of wastes (brine) after treatment needs to be addressed.

6. Land Retirement

This method involves cessation of irrigation on soils overlying shallow ground water that is high in selenium, salts, and/or boron.

Land retirement must occur in conjunction with reduced water imports so positive impacts are not offset by expanded water use on other shallow groundwater areas that are high in boron and salts within the basin.

Status: the U.S. Department of Interior has a land retirement team authorized under CVPIA, and the San Joaquin Drainage Relief Act in California Water Code Section 14900 authorized a land retirement system administered through the Department of Water Resources. This program is on a willing seller basis. Under this program all irrigation activities are to cease except for limited land management purposes, which will not contribute to existing drainage problems.

7. Active Alternative Land Management

Crop selection and irrigation practices could be modified to reduce high salt and boron drainage discharges. For example, deep-rooted crops that have the ability to use the shallow groundwater could reduce the need for irrigation. This method is seen as an alternative to land retirement.

Status: Three Grasslands Basin water districts in conjunction with the U. S. Bureau of Reclamation and U.S. Agricultural Research Service have a prototype project. This project includes sequential reuse in one of the districts.

8. Reduce Municipal and Industrial Sources of Salts

Source control, additional treatment processes, or application of waste to land would reduce salt load from municipal and industrial sources.

Application of waste to land could contribute indirectly to LSJR salinity through ground water accretions to the LSJR sytem. Application of saline and high boron waste to land could result in increased salt loading to ground water resulting in degradation of aquifer water quality.

Status: the Regional Board and local entities have active urban and industrial storm water management and dairy enforcement programs, but deal with only a fraction of the potential sources of salts. Also in June 1999, the City of Livingston submitted a salinity source control program as required by the Regional Board's C&D order that includes modifying their sewer ordinance.

9. Reduce Other Non-Point Sources of Salts and Boron

Salt and boron loads to the Lower SJR Basin could be reduced from other non-point sources, such as from urban storm water runoff, fertilizers, and animal waste.

Salts applied to land as fertilizer and animal waste contribute to loads that reach the groundwater and river. Control can occur at both the point of use and where these salts are discharged.

Status: the Regional Board and local entities have an active urban and industrial storm water management and dairy enforcement programs.

10. Ground Water Management

Managing shallow groundwater in certain agricultural areas could help to reduce subsurface drainage. Pumping and using the groundwater, would lower the shallow water table and reduce subsurface drainage volumes and salts.

Pumped water must be disposed of or applied to crops. Hence, this method must be used in conjunction with methods that reduce or dispose of salts. This option would need to be part of a ground water management plan that would assure protection of deep ground water quality.

Status: this method has not been used even though it was recommend by the SJVDP.

IV. INCREASING THE AMOUNT OF SALT EXPORTED FROM THE LSJR WATERSHED, INCLUDING THROUGH RE-OPERATION OF DRAINAGE AND REAL-TIME WATER QUALITY MANAGEMENT OR THROUGH THE USE OF AN OUT-OF-VALLEY DRAIN

1. Salt Disposal/Out of Valley Transport

Salt disposal requires transport out of the valley, long-term valley disposal and/or use of residual salts as a commodity. Out-of-valley transport could involve construction of disposal or transportation facilities to convey salts and boron from the LSJR Basin (e.g. an out- of-valley drain). Regional Board policy encourages construction of facilities to convey agricultural drain water.

Status: no facilities are in place for long-term in-valley disposal or for transport of salt and boron out of the valley. Salt and boron that does not leave the valley via the SJR or in harvested crops is stored in the soil or groundwater.

2. Controlled Timing Of Discharges (Real-Time Water Management)

The LSJR has some capacity to assimilate salinity and boron discharges through coordination of releases from both saline and better quality water sources. Scheduling high salinity and boron discharges to coincide with higher flows from reservoirs including flood flows, and higher quality discharges could be used to help meet water quality objectives.

This method has the potential to reduce peak loads (and concentrations) in the LSJR so that water quality objectives are met more frequently. This method has the further advantage of managing salt loads so that more salt leaves the LSJR Basin when there is assimilative capacity in the river. Real time management is of little or no value for reaches of the river that have limited assimilative capacity (that is, areas upstream of east side dilution flows) unless additional flow is provided.

Status: a pilot real time management effort was completed in June 1997. A Memorandum of Understanding (MOU) to promote the practice of real time management has been signed by several agencies. CALFED has funded a real time management project for two years beginning in April 1999.

For further detail, see technical reports by the San Joaquin Valley Drainage Program, San Joaquin Valley Drainage Implementation Program, CALFED, and the University of California Drainage/Salinity Programs.

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APPENDIX 3: EVALUATION OF CONTROL OPTION CONSISTENCY WITH APPLICABLE LAWS AND POLICES

Evaluation of Option 1: Prohibition of Discharge From All Agricultural Return Flows and Wetlands

Consistency with Laws and Policies	
Porter-Cologne: California Water Code Section 13243 provides that a Regional Board, in a water quality control plan, may specify certain conditions or areas where the discharge of waste, or certain types of waste is not permitted.	+
NPS Management Plan: Prohibition of discharge falls under tier 3 (effluent limitations and enforcement) of the State's NPS Management Plan. Tier three actions are considered the most stringent of the three tiered NPS management framework, however, the NPS management plan states that sequential movement through the tiers (e.g. tier 1, tier 2 , tier 3) is not required. Salt and boron in the LSJR has been a persistent long-term water quality problem that has not been corrected through self directed or voluntary actions, therefore a tier three approach may be warranted.	+
Consistency with Regional Board Basin Plan Policies	
The Water Quality Limited Segment Policy: The Water Quality Limited Segment Policy states that dischargers will be assigned or allocated a maximum allowable load of critical pollutants so that water quality objectives can be met in the segment. The policy does not indicate or specify how load allocations should be met, therefore, this control option is neutral with respect to the policy. Prohibition of discharge, however, could be considered to be a zero load allocation.	0
Watershed Policy: This option would impose a blanket prohibition on the entire LSJR watershed, this is inconsistent with the watershed policy which calls for focusing efforts on the most important problems and those sources contributing most significantly to those problems.	-
Policy for Obtaining Salt Balance in the San Joaquin Valley: The Policy for Obtaining Salt Balance in the San Joaquin Valley supports the construction of valley-wide drain as the only long-term solution for achieving a salt balance. This control option is not intended to achieve a salt balance in the San Joaquin Basin; it is rather intended to result in compliance with existing water quality objectives for salt an boron. This control option will neither support nor deter construction of a valley-wide drain therefore the option is neutral with respect to policy.	0
Consistency with State Board Basin Plan Policies	
Antidegradation Implementation Policy: The control option would not allow any new surface water discharges and some existing discharges would be eliminated. This control option may have the unintended consequence of impacting groundwater through salt build up. Uncontrolled groundwater accretions could cause further degradation of the LSJR.	0
Policy for Water Quality Control: This control option is consistent with the Policy for Water Quality Control because it would likely promote agricultural drainage re-use and increased water use efficiency as a mechanism to reduce discharges. The option is intended to implement an existing water quality objective only. No new objectives are proposed.	+
Statement of Policy with Respect to Maintaining High Quality of Water in California: The existing water quality in the LSJR is not better than quality prescribed in the Basin Plan. This control option would not result in any additional discharges. The control option is neutral with respect to the policy.	0
- = inconsistent; 0 = neutral; + = supportive	

Evaluation of Option 2: Geographically Based Prohibition of Discharge From All Agricultural Return Flows and Wetlands

Consistency with Laws and Policies	
Porter-Cologne: California Water Code Section 13243 provides that a Regional Board, in a water quality control plan, may specify certain conditions or areas where the discharge of waste, or certain types of waste is not permitted.	+
NPS Management Plan: Prohibition of discharge falls under tier 3 (effluent limitations and enforcement) of the States NPS Management Plan. Tier three actions are considered the most stringent of the three tiered NPS management framework, however, the NPS management plan states that sequential movement through the tiers (e.g. tier 1, tier 2 , tier 3) is not required. Salt and boron in the LSJR has been a persistent long-term water quality problem that has not been corrected through self directed or voluntary actions, therefore a tier three approach may be warranted.	+
Consistency with Regional Board Basin Plan Policies	
The Water Quality Limited Segment Policy: The Water Quality Limited Segment Policy states that dischargers will be assigned or allocated a maximum allowable load of critical pollutants so that water quality objectives can be met in the segment. The policy does not indicate or specify how load allocations should be met, therefore, this control option is neutral with respect to the policy. Prohibition of discharge, however, could be considered to be a zero load allocation.	0
Watershed Policy: The States 303(d) list identifies salt and boron impairment in the San Joaquin River as high priority for the development of TMDLs. This option would strategically impose a prohibition on high priority salt sources within the LSJR watershed, this is consistent with the watershed policy which calls for focusing efforts on the most important problems and those sources contributing most significantly to those problems.	+
Policy for Obtaining Salt Balance in the San Joaquin Valley: The Policy for Obtaining Salt Balance in the San Joaquin Valley supports the construction of valley-wide drain as the only long-term solution for achieving a salt balance. This control option is not intended to achieve in a salt balance in the San Joaquin Basin; it is rather intended to result in compliance with existing water quality objectives for salt an boron. This control option will neither support or deter construction of a valley-wide drain therefore the option is neutral with respect to policy.	0
Consistency with State Board Basin Plan Policies	
Antidegradation Implementation Policy: The control option would not allow any new surface water discharges and some existing discharges would be eliminated. This control option may have the unintended consequence of impacting groundwater through salt build up. Uncontrolled groundwater accretions could cause further degradation of the LSJR.	0
Policy for Water Quality Control: This control option is consistent with the Policy for Water Quality Control because it would likely promote agricultural drainage re-use and increased water use efficiency as a mechanism to reduce discharges. The option is intended to implement an existing water quality objective only. No new objectives are proposed.	+
Statement of Policy with Respect to Maintaining High Quality of Water in California: The existing water quality in the LSJR is not better than quality prescribed in the Basin Plan. This control option would not result in any additional discharges. The control option is neutral with respect to the policy.	0
- = inconsistent; 0 = neutral; + = supportive	

Evaluation of Option 3: Limited Prohibition of Discharge From Irrigation Return Flows and Wetlands Return Flows

Consistency with Laws and Policies	
Porter-Cologne: California Water Code Section 13243 provides that a Regional Board, in a water quality control plan, may specify certain conditions or areas where the discharge of waste, or certain types of waste is not permitted.	+
NPS Management Plan: Prohibition of discharge falls under tier 3 (effluent limitations and enforcement) of the States NPS Management Plan. Tier three actions are considered the most stringent of the three tiered NPS management framework, however, the NPS management plan states that sequential movement through the tiers (e.g. tier 1, tier 2 , tier 3) is not required. Salt and boron in the LSJR has been a persistent long-term water quality problem that has not been corrected through self directed or voluntary actions, therefore a tier three approach may be warranted.	+
Consistency with Regional Board Basin Plan Policies	
The Water Quality Limited Segment Policy: The Water Quality Limited Segment Policy states that dischargers will be assigned or allocated a maximum allowable load of critical pollutants so that water quality objectives can be met in the segment. The policy does not indicate or specify how load allocations should be met, therefore, this control option is neutral with respect to the policy. Prohibition of discharge, however, could be considered to be a zero load allocation.	+
Watershed Policy: The States 303(d) list identifies salt and boron impairment in the San Joaquin River as high priority for the development of TMDLs. In affect, this option would require the largest load reductions to occur in areas contributing the largest salt loads to the LSJR, this is consistent with the watershed policy, which calls for focusing efforts on the most important problems and those sources contributing most significantly to those problems.	0
Policy for Obtaining Salt Balance in the San Joaquin Valley: The Policy for Obtaining Salt Balance in the San Joaquin Valley supports the construction of valley-wide drain as the only long-term solution for achieving a salt balance. This control option is not intended to achieve a salt balance in the San Joaquin Basin; it is rather intended to result in compliance with existing water quality objectives for salt an boron. This control option will neither support nor deter construction of a valley-wide drain therefore the option is neutral with respect to policy.	0
Consistency with State Board Basin Plan Policies	
Antidegradation Implementation Policy: The control option would not allow any new surface water discharges and some existing discharges would be eliminated. This control option may have the unintended consequence of impacting groundwater through salt build up. Uncontrolled groundwater accretions could cause further degradation of the LSJR.	0
Policy for Water Quality Control: This control option is consistent with the Policy for Water Quality Control because it would likely promote agricultural drainage re-use and increased water use efficiency as a mechanism to reduce discharges. The option is intended to implement an existing water quality objective only. No new objectives are proposed.	+
Statement of Policy with Respect to Maintaining High Quality of Water in California: The existing water quality in the LSJR is not better than quality prescribed in the Basin Plan. This control option would not result in any additional discharges. The control option is neutral with respect to the policy.	0
- = *inconsistent; 0 = neutral; + = supportive*	

Evaluation of Option 4: NPDES Regulation of Point Source Discharges

Consistency with Laws and Policies	
Porter-Cologne: The NPDES program is a federal program, which was delegated to the SWRCB in 1973 when the USEPA granted approval to the State of California to issue NPDES permits. The State of California, through its water quality protection laws, has the authority to implement the NPDES provisions of the Federal CWA. Porter-Cologne incorporates the provisions of the NPDES permitting program. NPDES permits can be issued to point source dischargers to the control waste discharges to surface waters of the United States, however, the CWA, specifically disallows the use of NPDES permits regulate agricultural discharges from irrigation return flows. This control option proposes the continued use of NPDES permits to regulate discharges from municipal point sources, which is within the authority of the SWRCB and the RWQCB, and in conformance with the provisions of the CWA and Porter-Cologne.	+
NPS Management Plan: N/A – this option does not apply to non point source dischargers	0
Consistency with Regional Board Basin Plan Policies	
The Water Quality Limited Segment Policy: The Water Quality Limited Segment Policy states that dischargers will be assigned or allocated a maximum allowable load of critical pollutants so that water quality objectives can be met in the segment. This control option is consistent the policy because waste load allocations will be assigned to point source dischargers through NPDES permits.	0
Watershed Policy: The States 303(d) list identifies salt and boron impairment in the San Joaquin River as high priority for the development of TMDLs. This option focuses control efforts on the most important municipal and industrial point sources by establishing waste load allocations for direct discharges to surface waters. This option, however, focus efforts on point sources, which only comprise a small percent of the total salt loading to the san Joaquin River. This option is therefore neutral with the watershed policy, which calls for focusing efforts on the most important problems and those sources contributing most significantly to those problems.	+
Policy for Obtaining Salt Balance in the San Joaquin Valley: The Policy for Obtaining Salt Balance in the San Joaquin Valley supports the construction of valley-wide drain as the only long-term solution for achieving a salt balance. This control option is not intended to achieve in a salt balance in the San Joaquin Basin; it is rather intended to result in compliance with existing water quality objectives for salt an boron. This control option will neither support nor deter construction of a valley-wide drain therefore the option is neutral with respect to policy.	0
Consistency with State Board Basin Plan Policies	
Antidegradation Implementation Policy: The control option would not allow any new surface water discharges. This control option is intended to hold salt loading from point sources at it's current level during the short term and to decrease loading over the long term as waste load allocations are refined. No new discharges will occur as a result of implementation of this action because it only applies to existing NPDES discharges, this option is therefore consistent with the Antidegradation Implementation Policy.	+
Policy for Water Quality Control: This control option is consistent with the Policy for Water Quality Control because it would likely promote agricultural drainage re-use and increased water use efficiency as a mechanism to reduce surface water discharges. The option is intended to implement an existing water quality objective only. No new objectives are proposed.	+
Statement of Policy with Respect to Maintaining High Quality of Water in California: The existing water quality in the LSJR is not better than quality prescribed in the Basin Plan. This control option would not result in any additional discharges. The control option is neutral with respect to the policy.	0
- *= inconsistent; 0 = neutral; + = supportive*	

Evaluation of Option 5: Adoption of Waste Discharge Requirements for Individual Landowners

Consistency with Laws and Policies	
Porter-Cologne: Pursuant to the Porter-Cologne Water Quality Control Act (Water Code § 13260 et seq.) the Regional Board has the authority to issue individual or general waste discharge requirements, which govern the amount of pollution that can be discharged to a waterbody.	+
NPS Management Plan: WDRs fall under tier 3 (effluent limitations and enforcement) of the States NPS Management Plan. Tier three actions are considered the most stringent of the three tiered NPS management framework, however, the NPS management plan states that sequential movement through the tiers (e.g. tier 1, tier 2 , tier 3) is not required. Salt and boron in the LSJR has been a persistent long-term water quality problem that has not been corrected through self directed or voluntary actions, therefore a tier three approach may be warranted.	+
Consistency with Regional Board Basin Plan Policies	
The Water Quality Limited Segment Policy: The Water Quality Limited Segment Policy states that dischargers will be assigned or allocated a maximum allowable load of critical pollutants so that water quality objectives can be met in the segment. Issuance of WDRs would set salt and boron load allocations for individual dischargers through effluent limits contained in permits.	+
Watershed Policy: This option would use a blanket approach to controlling salt and boron discharges and therefore is inconsistent with the watershed policy, which calls for focusing efforts on the most important problems and those sources contributing most significantly to those problems.	-
Policy for Obtaining Salt Balance in the San Joaquin Valley: The Policy for Obtaining Salt Balance in the San Joaquin Valley supports the construction of valley-wide drain as the only long-term solution for achieving a salt balance. This control option is not intended to achieve in a salt balance in the San Joaquin Basin; it is rather intended to result in compliance with existing water quality objectives for salt an boron. This control option will neither support nor deter construction of a valley-wide drain therefore the option is neutral with respect to policy.	0
Consistency with State Board Basin Plan Policies	
Antidegradation Implementation Policy Under this control option, WDRs would be applied to existing discharges that are now operating under a waiver of WDRs or discharges that are not regualted. It is anticipated that the this control option would result in improved water quality in the San Joaquin River near Vernalis because existing discharge would likely need to be reduced to comply with new WDRs	0
Policy for Water Quality Control: This control option is consistent with the Policy for Water Quality Control because it would likely promote agricultural drainage re-use and increased water use efficiency to minimize discharges. The option is intended to implement an existing water quality objective only. No new objectives are proposed.	+
Statement of Policy with Respect to Maintaining High Quality of Water in California: The existing water quality in the LSJR is not better than quality prescribed in the Basin Plan. This control option would not result in any additional discharges. The control option is neutral with respect to the policy.	0
- *= inconsistent; 0 = neutral; + = supportive*	

Evaluation of Option 6: Adoption of Waste Discharge Requirements for Public Water Agencies

Consistency with Laws and Policies	
Porter-Cologne: Pursuant to the Porter-Cologne Water Quality Control Act (Water Code § 13260 et seq.) the Regional Board has the authority to issue individual or general waste discharge requirements, which govern the amount of pollution that can be discharged to a waterbody.	+
NPS Management Plan: WDRs fall under tier 3 (effluent limitations and enforcement) of the States NPS Management Plan. Tier three actions are considered the most stringent of the three tiered NPS management framework, however, the NPS management plan states that sequential movement through the tiers (e.g. tier 1, tier 2 , tier 3) is not required. Salt and boron in the LSJR has been a persistent long-term water quality problem that has not been corrected through self directed or voluntary actions, therefore a tier three approach may be warranted.	+
Consistency with Regional Board Basin Plan Policies	
The Water Quality Limited Segment Policy: The Water Quality Limited Segment Policy states that dischargers will be assigned or allocated a maximum allowable load of critical pollutants so that water quality objectives can be met in the segment. Issuance of WDRs would set salt and boron load allocations for Public water agencies (e.g. irrigation districts, water districts etc.) through effluent limits contained in permit requirements.	+
Watershed Policy: This option would use a blanket approach to controlling salt and boron discharges and therefore is inconsistent with the watershed policy, which calls for focusing efforts on the most important problems and those sources contributing most significantly to those problems.	-
Policy for Obtaining Salt Balance in the San Joaquin Valley: The Policy for Obtaining Salt Balance in the San Joaquin Valley supports the construction of valley-wide drain as the only long-term solution for achieving a salt balance. This control option is not intended to achieve in a salt balance in the San Joaquin Basin; it is rather intended to result in compliance with existing water quality objectives for salt an boron. This control option will neither support nor deter construction of a valley-wide drain therefore the option is neutral with respect to policy.	0
Consistency with State Board Basin Plan Policies	
Antidegradation Implementation Policy Under this control option, WDRs would be applied to existing discharges that are now operating under a waiver of WDRs or discharges that are not currently regualted. It is anticipated that the this control option would result in improved water quality in the San Joaquin River near Vernalis because existing discharge would likely need to be reduced to comply with new WDRs.	0
Policy for Water Quality Control: This control option is consistent with the Policy for Water Quality Control because it would likely promote agricultural drainage re-use and increased water use efficiency as a mechanism to reduce discharges. The option is intended to implement an existing water quality objective only. No new objectives are proposed.	+
Statement of Policy with Respect to Maintaining High Quality of Water in California: The existing water quality in the LSJR is not better than quality prescribed in the Basin Plan. This control option would not result in any additional discharges. The control option is neutral with respect to the policy.	0
- *= inconsistent; 0 = neutral; + = supportive*	

Evaluation of Option 7: Geographically Focused Waste Discharge Requirements

Consistency with Laws and Policies	
Porter-Cologne: Pursuant to the Porter-Cologne Water Quality Control Act (Water Code § 13260 et seq.) the Regional Board has the authority to issue individual or general waste discharge requirements, which govern the amount of pollution that can be discharged to a waterbody.	+
NPS Management Plan WDRs fall under tier 3 (effluent limitations and enforcement) of the States NPS Management Plan. Tier three actions are considered the most stringent of the three tiered NPS management framework, however, the NPS management plan states that sequential movement through the tiers (e.g. tier 1, tier 2 , tier 3) is not required. Salt and boron in the LSJR has been a persistent long-term water quality problem that has not been corrected through self directed or voluntary actions, therefore a tier three approach may be warranted.	+
Consistency with Regional Board Basin Plan Policies	
The Water Quality Limited Segment Policy: The Water Quality Limited Segment Policy states that dischargers will be assigned or allocated a maximum allowable load of critical pollutants so that water quality objectives can be met in the segment. Issuance of a WDR would set salt and boron load allocations for the USBR for salts in DMC supply water	+
Watershed Policy: The States 303(d) list identifies salt and boron impairment in the San Joaquin River as high priority for the development of TMDLs. This option would focus regulatory action on the largest salt sources in the LSJR watershed. This option is therefore consistent with the watershed policy, which calls for focusing efforts on the most important problems and those sources contributing most significantly to those problems.	+
Policy for Obtaining Salt Balance in the San Joaquin Valley: The Policy for Obtaining Salt Balance in the San Joaquin Valley supports the construction of valley-wide drain as the only long-term solution for achieving a salt balance. This control option is not intended to achieve in a salt balance in the San Joaquin Basin; it is rather intended to result in compliance with existing water quality objectives for salt an boron. This control option will neither support nor deter construction of a valley-wide drain therefore the option is neutral with respect to policy.	0
Consistency with State Board Basin Plan Policies	
Antidegradation Implementation Policy: Under this control option, WDRs would be applied to existing discharges that are now unregulated. It is anticipated that the this control option would result in improved water quality in the San Joaquin River near Vernalis because existing discharges would likely need to be reduced to comply with the new WDRs.	0
Policy for Water Quality Control: This control option is consistent with the Policy for Water Quality Control because it would likely promote agricultural drainage re-use and increased water use efficiency as a mechanism to reduce discharges. The option is intended to implement an existing water quality objective only. No new objectives are proposed.	+
Statement of Policy with Respect to Maintaining High Quality of Water in California: The existing water quality in the LSJR is not better than quality prescribed in the Basin Plan. This control option would not result in any additional discharges. The control option is neutral with respect to the policy.	0
- = inconsistent; 0 = neutral; + = supportive	

Evaluation of Option 8: Adoption of Waste Discharge Requirements For The USBR/CVP

Consistency with Laws and Policies	
Porter-Cologne: Pursuant to the Porter-Cologne Water Quality Control Act (Water Code § 13260 et seq.) the Regional Board has the authority to issue individual or general waste discharge requirements, which govern the amount of pollution that can be discharged to a waterbody.	+
NPS Management Plan: WDRs fall under tier 3 (effluent limitations and enforcement) of the States NPS Management Plan. Tier three actions are considered the most stringent of the three tiered NPS management framework, however, the NPS management plan states that sequential movement through the tiers (e.g. tier 1, tier 2 , tier 3) is not required. Salt and boron in the LSJR has been a persistent long-term water quality problem that has not been corrected through self directed or voluntary actions, therefore a tier three approach may be warranted.	+
Consistency with Regional Board Basin Plan Policies	
The Water Quality Limited Segment Policy: The Water Quality Limited Segment Policy states that dischargers will be assigned or allocated a maximum allowable load of critical pollutants so that water quality objectives can be met in the segment. Issuance of and individual WDR to the USBR would set a salt and boron load allocation in the form of effluent limits placed on the CVP.	+
Watershed Policy: The States 303(d) list identifies salt and boron impairment in the San Joaquin River as high priority for the development of TMDLs. This option would focus regulatory action on one of the largest salt sources in the LSJR watershed and is therefore consistent with the watershed policy, which calls for focusing efforts on the most important problems and those sources contributing most significantly to those problems.	+
Policy for Obtaining Salt Balance in the San Joaquin Valley: The Policy for Obtaining Salt Balance in the San Joaquin Valley supports the construction of valley-wide drain as the only long-term solution for achieving a salt balance. This control option is not intended to achieve in a salt balance in the San Joaquin Basin; it is rather intended to result in compliance with existing water quality objectives for salt an boron. This option would, however, have the added benefit of facilitating a salt balance in the LSJR watershed by accounting for salt imports to the watershed. The USBR could choose to meet their DMC salt load allocation through mitigation, including construction of a valley-wide drain. This control option may provide incentives for construction of a valley-wide drain; therefore the option is consistent with respect to policy.	0
Consistency with State Board Basin Plan Policies	
Antidegradation Implementation Policy: Under this control option, a WDR would be applied to an existing discharge that is now unregulated. It is anticipated that the this control option would result in improved water quality in the San Joaquin River near Vernalis because the existing discharge would likely need to be reduced to comply with a new WDR.	0
Policy for Water Quality Control: This control option is consistent with the Policy for Water Quality Control because it would likely promote agricultural drainage re-use and increased water use efficiency as a mechanism to reduce discharges. The option is intended to implement an existing water quality objective only. No new objectives are proposed.	+
Statement of Policy with Respect to Maintaining High Quality of Water in California	0
- *= inconsistent; 0 = neutral; + = supportive*	

Evaluation of Option 9:Adoption of General Waste Discharge Requirements for Individual Agricultural and Wetland Dischargers

Consistency with Consistency with Laws and Policies	
Porter-Cologne: Pursuant to the Porter-Cologne Water Quality Control Act (Water Code § 13260 et seq.) the Regional Board has the authority to issue individual or general waste discharge requirements, which govern the amount of pollution that can be discharged to a waterbody.	+
NPS Management Plan General WDRs fall under tier 3 (effluent limitations and enforcement) of the States NPS Management Plan. Tier three actions are considered the most stringent of the three tiered NPS management framework, however, the NPS management plan states that sequential movement through the tiers (e.g. tier 1, tier 2 , tier 3) is not required. Salt and boron in the LSJR has been a persistent long-term water quality problem that has not been corrected through self directed or voluntary actions, therefore a tier three approach may be warranted.	+
Consistency with Regional Board Basin Plan Policies	
The Water Quality Limited Segment Policy: The Water Quality Limited Segment Policy states that dischargers will be assigned or allocated a maximum allowable load of critical pollutants so that water quality objectives can be met in the segment. General WDRs would set salt and boron load allocations for individual dischargers.	+
Watershed Policy: This option would use a blanket approach to controlling salt and boron discharges and therefore is inconsistent with the watershed policy, which calls for focusing efforts on the most important problems and those sources contributing most significantly to those problems.	-
Policy for Obtaining Salt Balance in the San Joaquin Valley: The Policy for Obtaining Salt Balance in the San Joaquin Valley supports the construction of valley-wide drain as the only long-term solution for achieving a salt balance. This control option is not intended to achieve in a salt balance in the San Joaquin Basin; it is rather intended to result in compliance with existing water quality objectives for salt an boron. This control option will neither support nor deter construction of a valley-wide drain therefore the option is neutral with respect to policy.	0
Consistency with State Board Basin Plan Policies	
Antidegradation Implementation Policy: General WDRs would be applied to existing discharges that are now operating under a waiver of WDRs or discharges that are not currently regulated. It is anticipated that the this control option would result in improved water quality in the San Joaquin River near Vernalis because existing discharge would likely need to be reduced to comply with load allocation.	0
Policy for Water Quality Control: This control option is consistent with the Policy for Water Quality Control because it would likely promote agricultural drainage re-use and increased water use efficiency as a mechanism to reduce discharges. The option is intended to implement an existing water quality objective only. No new objectives are proposed.	+
Statement of Policy with Respect to Maintaining High Quality of Water in California: The existing water quality in the LSJR is not better than quality prescribed in the Basin Plan. This control option would not result in any additional discharges. The control option is neutral with respect to the policy.	0
- *= inconsistent; 0 = neutral; + = supportive*	

Evaluation of Option 10: Adoption of General Waste Discharge Requirements for Public Water Agencies

Consistency with Consistency with Laws and Policies	
Porter-Cologne: Pursuant to the Porter-Cologne Water Quality Control Act (Water Code § 13260 et seq.) the Regional Board has the authority to issue individual or general waste discharge requirements, which govern the amount of pollution that can be discharged to a waterbody.	+
NPS Management Plan: General WDRs fall under tier 3 (effluent limitations and enforcement) of the States NPS Management Plan. Tier three actions are considered the most stringent of the three tiered NPS management framework, however, the NPS management plan states that sequential movement through the tiers (e.g. tier 1, tier 2 , tier 3) is not required. Salt and boron in the LSJR has been a persistent long-term water quality problem that has not been corrected through self directed or voluntary actions, therefore a tier three approach may be warranted.	+
Consistency with Regional Board Basin Plan Policies	
The Water Quality Limited Segment Policy: The Water Quality Limited Segment Policy states that dischargers will be assigned or allocated a maximum allowable load of critical pollutants so that water quality objectives can be met in the segment. Using this option, General WDRs would set salt and boron load allocations for public water agencies.	+
Watershed Policy This option would use a blanket approach to controlling salt and boron discharges and therefore is inconsistent with the watershed policy, which calls for focusing efforts on the most important problems and those sources contributing most significantly to those problems.	-
Policy for Obtaining Salt Balance in the San Joaquin Valley: The Policy for Obtaining Salt Balance in the San Joaquin Valley supports the construction of valley-wide drain as the only long-term solution for achieving a salt balance. This control option is not intended to achieve in a salt balance in the San Joaquin Basin; it is rather intended to result in compliance with existing water quality objectives for salt an boron. This control option will neither support nor deter construction of a valley-wide drain therefore the option is neutral with respect to policy.	0
Consistency with State Board Basin Plan Policies	
Antidegradation Implementation Policy: General WDRs would be applied to existing discharges that are now operating under a waiver of WDRs or discharges that are not currently regulated. It is anticipated that the this control option would result in improved water quality in the San Joaquin River near Vernalis because existing discharges would likely need to be reduced to comply with load allocations specified in General WDRs.	0
Policy for Water Quality Control: This control option is consistent with the Policy for Water Quality Control because it would likely promote agricultural drainage re-use and increased water use efficiency as a mechanism to reduce discharges. The option is intended to implement an existing water quality objective only. No new objectives are proposed.	+
Statement of Policy with Respect to Maintaining High Quality of Water in California: The existing water quality in the LSJR is not better than quality prescribed in the Basin Plan. This control option would not result in any additional discharges. The control option is neutral with respect to the policy.	0
- = inconsistent; 0 = neutral; + = supportive	

Evaluation of Option 11: Adoption of Geographically Focused General Waste Discharge Requirements

Consistency with Consistency with Laws and Policies	
Porter-Cologne: Pursuant to the Porter-Cologne Water Quality Control Act (Water Code § 13260 et seq.) the Regional Board has the authority to issue individual or general waste discharge requirements, which govern the amount of pollution that can be discharged to a waterbody.	+
NPS Management Plan: General WDRs fall under tier 3 (effluent limitations and enforcement) of the States NPS Management Plan. Tier three actions are considered the most stringent of the three tiered NPS management framework, however, the NPS management plan states that sequential movement through the tiers (e.g. tier 1, tier 2 , tier 3) is not required. Salt and boron in the LSJR has been a persistent long-term water quality problem that has not been corrected through self directed or voluntary actions, therefore a tier three approach may be warranted.	+
Consistency with Regional Board Basin Plan Policies	
The Water Quality Limited Segment Policy: The Water Quality Limited Segment Policy states that dischargers will be assigned or allocated a maximum allowable load of critical pollutants so that water quality objectives can be met in the segment. General WDRs would be used to set salt and boron load allocations for public water agencies.	+
Watershed Policy: The States 303(d) list identifies salt and boron impairment in the San Joaquin River as high priority for the development of TMDLs. This option would focus regulatory action on the largest salt sources in the LSJR watershed. This option is therefore consistent with the watershed policy, which calls for focusing efforts on the most important problems and those sources contributing most significantly to those problems.	+
Policy for Obtaining Salt Balance in the San Joaquin Valley: The Policy for Obtaining Salt Balance in the San Joaquin Valley supports the construction of valley-wide drain as the only long-term solution for achieving a salt balance. This control option is not intended to achieve in a salt balance in the San Joaquin Basin; it is rather intended to result in compliance with existing water quality objectives for salt an boron. This control option will neither support nor deter construction of a valley-wide drain therefore the option is neutral with respect to policy.	0
Consistency with State Board Basin Plan Policies	
Antidegradation Implementation Policy: General WDRs would be applied to existing discharges that are now operating under a waiver of WDRs or discharges that are not currently regulated. It is anticipated that the this control option would result in improved water quality in the San Joaquin River near Vernalis because existing discharges would likely need to be reduced to comply with load allocations specified in General WDRs.	0
Policy for Water Quality Control: This control option is consistent with the Policy for Water Quality Control because it would likely promote agricultural drainage re-use and increased water use efficiency as a mechanism to reduce discharges. The option is intended to implement an existing water quality objective only. No new objectives are proposed.	+
Statement of Policy with Respect to Maintaining High Quality of Water in California: The existing water quality in the LSJR is not better than quality prescribed in the Basin Plan. This control option would not result in any additional discharges. The control option is neutral with respect to the policy.	0
- = inconsistent; 0 = neutral; + = supportive	

Evaluation of Option 12: Implementation of the Existing Waiver of Waste Discharge Requirements for Discharges From Irrigated Lands

Consistency with Laws and Policies	
Porter-Cologne: Section 13269 of the California Water Code allows the Regional Board to waive waste discharge requirements for a specific discharge or specific type of discharge if the waiver is not against the public interest and the waiver is conditional.	+
NPS Management Plan: Waivers of WDRs fall under tier two (Regulatory Based Encouragement of Management Practices) of the States NPS Management Plan. The NPS plan calls for the use of the lowest tier that is likely to result in attainment of water quality standards; however, the NPS management plan also states that sequential movement through the tiers (e.g. tier 1, tier 2 , tier 3) is not required. Salt and boron in the LSJR has been a persistent long-term water quality problem that has not been corrected through self directed or voluntary actions, therefore a tier two approach may be warranted.	+
Consistency with Regional Board Basin Plan Policies	
The Water Quality Limited Segment Policy: The Water Quality Limited Segment Policy states that dischargers will be assigned or allocated a maximum allowable load of critical pollutants so that water quality objectives can be met in the segment. The existing Waiver of WDRs does not set salt and boron load allocations for dischargers, however, the control program could stipulate compliance with load allocations as a condition for being regulated under the waiver.	0
Watershed Policy: The States 303(d) list identifies salt and boron impairment in the San Joaquin River as high priority for the development of TMDLs. Low threat dischargers are expected to be able to comply with waiver conditions relatively easily or potentially be exempted from waiver conditions (dischargers demonstrating that they are not impacting water quality). High threat dischargers will likely be required to implement more extensive management practices to comply with waiver conditions. In effect, more regulatory control will be placed on the more significant salt sources. This option is consistent with the watershed policy, which calls for focusing efforts on the most important problems and those sources contributing most significantly to those problems.	+
Policy for Obtaining Salt Balance in the San Joaquin Valley: The Policy for Obtaining Salt Balance in the San Joaquin Valley supports the construction of valley-wide drain as the only long-term solution for achieving a salt balance. This control option is not intended to achieve in a salt balance in the San Joaquin Basin; it is rather intended to result in compliance with existing water quality objectives for salt an boron. This control option will neither support nor deter construction of a valley-wide drain therefore the option is neutral with respect to policy.	0
Consistency with State Board Basin Plan Policies	
Antidegradation Implementation Policy: It is anticipated that the this control option would result in improved water quality in the San Joaquin River near Vernalis because existing discharges would likely need to be reduced to comply with waiver conditions.	0
Policy for Water Quality Control: This control option is consistent with the Policy for Water Quality Control because it would likely promote agricultural drainage re-use and increased water use efficiency as a mechanism to reduce discharges. The option is intended to implement an existing water quality objective only. No new objectives are proposed.	+
Statement of Policy with Respect to Maintaining High Quality of Water in California: The existing water quality in the LSJR is not better than quality prescribed in the Basin Plan. This control option would not result in any additional discharges. The control option is neutral with respect to the policy.	0
- = inconsistent; 0 = neutral; + = supportive	

Evaluation of Option 13: Implementation of a New Waiver of Waste Discharge Requirements for Participants of a Regional Board Approved Real-time Management Program

Consistency with Laws and Policies	
Porter-Cologne: Section 13269 of the California Water Code allows the Regional Board to waive waste discharge requirements for a specific discharge or specific type of discharge if the waiver is not against the public interest and the waiver is conditional.	+
NPS Management Plan: Waivers of WDRs fall under tier two (Regulatory Based Encouragement of Management Practices) of the States NPS Management Plan. The NPS plan calls for the use of the lowest tier that is likely to result in attainment of water quality standards; however, the NPS management plan also states that sequential movement through the tiers (e.g. tier 1, tier 2 , tier 3) is not required. Salt and boron in the LSJR has been a persistent long-term water quality problem that has not been corrected through self directed or voluntary actions, therefore a tier two approach may be warranted.	+
Consistency with Regional Board Basin Plan Policies	
The Water Quality Limited Segment Policy: The Water Quality Limited Segment Policy states that dischargers will be assigned or allocated a maximum allowable load of critical pollutants so that water quality objectives can be met in the segment. A new waiver of WDRs for participants of a real-time management program would require dischargers to comply with real-time load allocations.	+
Watershed Policy: The States 303(d) list identifies salt and boron impairment in the San Joaquin River as high priority for the development of TMDLs. Low threat dischargers are expected to be able to comply with waiver conditions relatively easily (potentially requiring no action to comply with real-time load allocations). High threat dischargers will likely be required to implement more extensive management practices to comply with waiver conditions. In effect, more regulatory control will be placed on the most important salt sources. This option is consistent with the watershed policy, which calls for focusing efforts on the most important problems and those sources contributing most significantly to those problems.	+
Policy for Obtaining Salt Balance in the San Joaquin Valley: The Policy for Obtaining Salt Balance in the San Joaquin Valley supports the construction of valley-wide drain as the only long-term solution for achieving a salt balance. This control option is not intended to achieve in a salt balance in the San Joaquin Basin; it is rather intended to result in compliance with existing water quality objectives for salt an boron. This control option will neither support nor deter construction of a valley-wide drain therefore the option is neutral with respect to policy.	0
Consistency with State Board Basin Plan Policies	
Antidegradation Implementation Policy: It is anticipated that the this control option would result in improved water quality in the San Joaquin River near Vernalis because existing discharges would likely be reduced during critical time to comply with real-time load allocations.	0
Policy for Water Quality Control: This control option is consistent with the Policy for Water Quality Control because it would likely promote agricultural drainage re-use and increased water use efficiency as a mechanism to reduce discharges. The option is intended to implement an existing water quality objective only. No new objectives are proposed.	+
Statement of Policy with Respect to Maintaining High Quality of Water in California: The existing water quality in the LSJR is not better than quality prescribed in the Basin Plan. This control option would not result in any additional discharges. The control option is neutral with respect to the policy.	0
- = inconsistent; 0 = neutral; + = supportive	

Evaluation of Option 14: Promote voluntary efforts to comply with water quality objectives

Consistency with Laws and Policies	
Porter-Cologne: This option is neutral with respect to Porter -Cologne.	0
NPS Management Plan: Voluntary actions fall under tier one (self directed action) of the States NPS Management Plan. The NPS plan calls for the use of the lowest tier that is likely to result in attainment of water quality standards; Tier one is the lowest tier.	+
Consistency with Regional Board Basin Plan Policies	
The Water Quality Limited Segment Policy: The Water Quality Limited Segment Policy states that dischargers will be assigned or allocated a maximum allowable load of critical pollutants so that water quality objectives can be met in the segment. Voluntary implementation would not include load allocations; therefore this option by itself would not be consistent with policy.	-
Watershed Policy: The States 303(d) list identifies salt and boron impairment in the San Joaquin River as high priority for the development of TMDLs. The watershed policy calls for focusing efforts on the most important problems and those sources contributing most significantly to those problems. This option is inconsistent with the policy because control efforts may or may not be focused on priority sources since implementation is voluntary.	-
Policy for Obtaining Salt Balance in the San Joaquin Valley: The Policy for Obtaining Salt Balance in the San Joaquin Valley supports the construction of valley-wide drain as the only long-term solution for achieving a salt balance. This control option is not intended to achieve in a salt balance in the San Joaquin Basin; it is rather intended to result in compliance with existing water quality objectives for salt an boron. This control option will neither support nor deter construction of a valley-wide drain therefore the option is neutral with respect to policy.	0
Consistency with State Board Basin Plan Policies	
Antidegradation Implementation Policy: Since this option relies on voluntary implementation on management practices no assurance can be provided that surface and ground water degradation will be prevented. This option, however, would not specifically authorize any new discharges, instead it is an attempt to improve the quality of existing or unregulated discharges. Therefore the option is neutral with respect to the policy.	0
Policy for Water Quality Control: This control option is neutral with respect to the Policy for Water Quality Control. The option is intended to implement an existing water quality objective only. No new water quality objectives are proposed.	0
Statement of Policy with Respect to Maintaining High Quality of Water in California: The existing water quality in the LSJR is not better than quality prescribed in the Basin Plan. This control option would not result in any additional discharges. The control option is neutral with respect to the policy.	0
- = inconsistent; 0 = neutral; + = supportive	

Evaluation of Option 14: Option 15: Initiate a Management Agency Agreement (MAA) between the Regional Board, SWRCB, and the USBR

Consistency with Laws and Policies	
Porter-Cologne: This option is neutral with respect to Porter -Cologne.	0
NPS Management Plan: Establishment of MAAs falls under tier two (Regulatory Based Encouragement) of the States NPS Management Plan. The NPS plan calls for the use of the lowest tier that is likely to result in attainment of water quality standards. Sequential movement through the tiers (e.g., Tier 1 to Tier 2 to Tier 3) is not required for persistent or serious water quality problems. The SWRCB has already directed the USBR, through the water rights process, to ensure that the Vernalis salinity objectives are met. Water quality exceededences have occurred at Vernalis despite the USBR on-going efforts, therefore, a tier two approach is warranted.	+
Consistency with Regional Board Basin Plan Policies	
The Water Quality Limited Segment Policy: The Water Quality Limited Segment Policy states that dischargers will be assigned or allocated a maximum allowable load of critical pollutants so that water quality objectives can be met in the segment. An MAA would not include enforceable load allocations; therefore this option by itself would not be consistent with policy.	-
Watershed Policy: The States 303(d) list identifies salt and boron impairment in the San Joaquin River as high priority for the development of TMDLs. The watershed policy calls for focusing efforts on the most important problems and those sources contributing most significantly to those problems. This option is consistent with the policy because it would focus efforts on one of the largest sources of salt in the LSJR watershed.	+
Policy for Obtaining Salt Balance in the San Joaquin Valley: The Policy for Obtaining Salt Balance in the San Joaquin Valley supports the construction of valley-wide drain as the only long-term solution for achieving a salt balance. This control option is not intended to achieve in a salt balance in the San Joaquin Basin; it is rather intended to result in compliance with existing water quality objectives for salt an boron. This control option will neither support nor deter construction of a valley-wide drain therefore the option is neutral with respect to policy.	0
Consistency with State Board Basin Plan Policies	
Antidegradation Implementation Policy: It is anticipated that the this control option would result in improved water quality in the San Joaquin River near Vernalis because implementation of management practices or other mitigation would likely be required as condition of an MAA.	0
Policy for Water Quality Control: This control option is neutral with respect to the Policy for Water Quality Control. The option is intended to implement an existing water quality objective only. No new water quality objectives are proposed.	0
Statement of Policy with Respect to Maintaining High Quality of Water in California: The existing water quality in the LSJR is not better than quality prescribed in the Basin Plan. This control option would not result in any additional discharges. The control option is neutral with respect to the policy.	0
- = inconsistent; 0 = neutral; + = supportive	

APPENDIX 4: ECONOMIC ANALYSIS FOR THE IMPLEMENTATION OF A CONTROL PROGRAM FOR SALT AND BORON DISCHARGES TO THE LOWER SAN JOAQUIN RIVER

This appendix has been developed to estimate costs associated with implementing a control program for salt and boron discharges to the Lower San Joaquin River (LSJR). The economic analysis is intended to provide estimates of the major direct costs associated with a limited number of salt and boron control strategies. The analysis is not intended to evaluate all of the cost benefits, externalities or potential economic outcomes that could occur as a result of the proposed salt and boron control program implementation (i.e. positive or negative change in tax revenues due to potential changes in land use patterns etc.). The economic effects of potential changes in agricultural productivity have not been evaluated as part of this analysis.

This economic analysis provides estimates for the following three types of costs.

1) State government cost to implement 15 water quality implementation options
2) Discharger cost to implement four alternative salt and boron control programs
3) Existing/ongoing costs for agricultural production in the LSJR watershed

The state government costs to implement regulatory water quality controls are used in Section 3.4.5 of the accompanying staff report to help screen out the most viable regulatory implementation options. These implementation options are used to develop four alternative implementation programs, including a no action alternative. The cost to dischargers (primarily farmers and wetland operators) associated with implementing each of these four alternatives is estimated. The current cost for agricultural production in the LSJR watershed is also estimated to provide a feel for the costs associated with the recommended implementation program relative to the current costs of agricultural production. The appendix also includes a summary of the potential sources of financing for the proposed implementation program.

I. STATE GOVERNMENT COSTS

The primary state government costs to implement salt and boron controls are comprised of personnel costs. In general, state government costs are proportional to the level of regulatory oversight needed to implement a given control action. The state government costs associated with the implementation options described in Section 3.4 of the staff report are estimated to provide the relative costs of each implementation option. The cost of one option can be weighed against the cost of another option.

The costs to implement a prohibition of discharge (implementation options 1-3) are based on best professional judgment and previous staff experience implementing similar programs and are estimated to range from 2-5 personnel years (PYs) per year.

The cost for implementation option 4 (Continued National Pollutant Discharge Elimination System (NPDES) regulation of point source discharges) is assumed to be minimal because NPDES regulation of point sources would occur in a similar manner independent of any salt and boron control program. The additional state costs needed to implement proposed total maximum daily load (TMDL) waste load allocations in existing NPDES permits is considered to be insignificant.

The State Water Resources Control Board (State Water Board) has developed unit costs factors for a number of activities that are typically preformed to implement Regional Water Quality Control Board (Regional Board) regulatory programs. These unit cost factors were used estimate the state costs associated with implementation options 5-11, which are described in Section 3.4 of the staff report. The unit cost factors are multiplied by the estimated number of “units” required to implement each implementation option to determine the total cost for completing the required actions (Table D-1). For example, implementation option 6 would require issuance of waste discharge requirements (WDRs) to water agencies in the LSJR watershed. The unit cost factor for issuance of WDRs (Category II with CEQA) is 368 hours. We estimate that approximately 30 public water agencies would be regulated under WDRs pursuant to implementation option 6, therefore the total state cost for this single activity is equal to 30 times 368 hours, or 11,040 hours. Implementation option 6 would require other staff actions beside initial issuance of WDRs. Additional resources would be needed to conduct inspections, review monitoring data, and conduct enforcement of permit conditions. The total cost of a particular implementation option is equal to the sum of the costs for each type of action that must be undertaken to fully execute the implementation option.

The State Water Board unit cost factors were developed to provide uniform estimates of the amount of time needed to implement the various aspects of existing Regional Board programs. In some cases, the regulatory control actions presented in this staff report involve applying conventional regulatory tools to previously unregulated discharge sectors and therefore caution must be used when applying generic unit cost factors to regulation of agricultural and wetland drainage in the LSJR watershed. Additional costs have been added to certain regulatory implementation options to be conservative and to account for uncertainties in the use of the generic unit cost factors. The unit cost factors used to estimate the total estimated state costs required for implementation options 5-11 are presented in Table D-1.

Table D-1: Calculation of State Costs for Implementation Options 5-11

RWQCB Staff Activity	Unit cost factor (hours)	Option 5[1] Individual WDRs		Option 6[2] Water agency WDRs		Option 7[3] Focused WDRs		Option 8 CVP/USBR WDR		Option 9[1] Individual General WDR-		Option10[2] Water agency General WDR-		Option 11[3] Focused General WDR-	
		# of units	Cost (hours)	# of units	Cost (hours)	# of units	Cost (hours)	# of units	Cost (hours)	# of units	Cost (hours)	# of units	Cost (hours)	# of units	Cost (hours)
PROGRAM STARTUP COSTS															
Issue new Category II WDR w/ CEQA	368	900	331,200	30	11,040	10	3,680	1	368						
Issue General WDR	700		0							2	1,400	2	1,400	7	4,900
Enroll Discharger in General WDR	12		0							900	10,800	30	360	10	120
RECURRING ANNUAL COSTS[4]															
Conduct Inspection (Cat. 1A)	18			30	540	10	180	1	18			30	540	10	180
Conduct Inspection (all other categories)	10	900	9,000							900	9,000				
Conduct Complaint investigation	12	9	108	3	36	2	24	1	12	9	108	3	36	1	12
Level 1 Review of SMR	1	450	450							450	450				
Level 2 Review of SMR	5	441	2,205							441	2,205				
Level 3 Review of SMR	14	9	126	30	420	10	140			9	126	30	420	10	140
Permit Oversight	8	900	7,200	30	240	10	80	5	40	900	7,200	30	240	10	80
Appeals of Board Actions	169	9	1,521	3	507	2	338								
Petitions Appealing Enforcement Action	169	9	1,521	3	507	2	338								
Program Administration	4	900	3,600	30	120	10	40			900	3,600	30	120	10	40
Informal Enforcement	7	23	158	3	21	2	14			23	158	3	21	2	14
Informal Enforcement follow-up	5	23	113	3	15	2	10			23	113	3	15	2	10
Enforcement Letter	8	23	180	3	24	2	16			23	180	3	24	2	16
Enforcement Letter Follow Up	8	23	180	3	24	2	16			23	180	3	24	2	16
Issue Notice to Comply w/ Follow Up	7	23	158	3	21	2	14			23	158	3	21	2	14
Issue Cleanup &Abatement Order	135	4	540	3	405	2	270			4	540	3	405	2	270
Issue Cease & Desist Order	203	4	812	3	609	2	406			4	812	3	609	2	406
Issue Simple ACL w/ Follow Up	74	4	296	3	222	2	148			4	296	3	222	2	148
Issue Time Schedule Order/ Follow Up	203	4	812	3	609	2	406			4	812	3	609	2	406
Referrals to Attorney General	237	4	948	3	711	2	474			4	948	3	711	2	474
Third Party Action W/ follow up	17	4	68	3	51	2	34			4	68	3	51	2	34
Additional Added Costs[5]			0		0		1,776		888		0		1,776		1,776
Total hours (startup and recurring)			361,195		16,122		8,404		1,326		39,153		7,604		9,056
Total PYs [6]			203		9		5		0.75		22		4		5

Summary of total costs	Option 5 Individual WDRs	Option 6 Water agency WDRs	Option 7 Focused WDRs	Option 8 CVP/USBR WDR	Option 9 General WDR-individual	Option10 General WDR-water agency	Option 11 General WDR-focused
	cost in PYs	cost in PYs	cost in PYs	cost in PYs	cost in PYs	cost in PYs	cost in PYs
Program start up Cost	**included in annual cost**	**6.2**	**2.1**	**0.2**	**0.8**	**0.8**	**2.8**
Annual program admin (after start up)	**203.4**	**2.9**	**2.7**	**0.54**	**21.3**	**3.5**	**2.3**

1 -Assumes that WDRs will be applied to 900 dischargers per year for 10 years until all estimated 9,000 dischargers in the project area are regulated
2 -Assumes that WDRs will be applied to 30 public water agencies.
3 -Assumes WDRs will be applied to 30% of all public water agencies (10 public water agencies).
4 -# of units to complete each RWQCB staff activity based on staff best professional judgment.
5 -Added cost for uncertainty of applying generic unit costs to formerly un-regulated activities.
6 -1 PY = 1776 hours

The costs for implementation options 12-13 are based on best professional judgment because no quantitative means was available to estimate these costs. Table D-2 provides a summary of the expected costs for each implementation option that was evaluated.

Table D-2 Summary of State cost for implementation options

Option #	Description	Estimated cost (PYs)
1	Prohibition of discharge of all agricultural return flows and discharges from wetlands	2-5 per year
2	Geographically focused prohibition of discharge of all agricultural return flows and discharges from wetlands	2-5 per year
3	Limited prohibition of discharge from irrigation return flows and wetlands return flows	4-5 per year
4	Continued NPDES regulation of point source discharges	<1 per year
5	Adoption waste discharge requirements for individual landowners	200+
6	Adoption of waste discharge requirements for public water agencies	6 for startup, 3 per year thereafter
7	Geographically focused waste discharge requirements	2 for startup, 3 per year thereafter
8	Adoption of waste discharge requirements for the USBR/CVP	<1 per year
9	Adoption of general waste discharge requirements for individual agricultural and wetland dischargers	2 for startup and 21 per year thereafter
10	Adoption of general waste discharge requirements for public water agencies	1 for startup, 4 per year thereafter
11	Adoption of geographically focused general waste discharge requirements	3 for startup, 2 per year thereafter
12	Implement the salt and boron TMDL through the existing waiver of waste discharge requirements for discharges from irrigated lands	1 per year
13	Implementation of a waiver of waste requirements for dischargers participating in a Regional Board approved real-time management program	1-2 per year
14	Promote voluntary efforts to comply with water quality objectives	<1 per year
15	Initiate a Management Agency Agreement (MAA) between the Regional Board, State Water Board, and the USBR	<1 per year

II. DISCHARGER COSTS

Discharger costs to implement salt and boron controls include the costs to build, operate, and maintain the infrastructure required to capture, retain, treat, re-use, or re-operate saline drainage in a manner that will protect water quality. The required infrastructure may include evaporation and/or temporary retention ponds, conveyance facilities, and drainage re-circulation facilities. Any in-valley drainage solutions must also consider the cost to dispose of accumulated salts (landfill costs).

The costs to dischargers associated with the following four implementation alternatives are estimated to help identify a recommend program of implementation:

Alternative 1: No Project/No Action

Alternative 2: Prohibition of Discharge

Alternative 3: Fixed Base Load Allocations implemented through a focused general WDRs for public water agencies and an individual WDR for DMC discharges

Alternative 4

a) **Real-Time Load Allocations** implemented through combination waiver of WDRs, focused general WDRs, and Management Agency Agreement (MAA) to address DMC discharges.

b) **Real-Time Load Allocations with Re-Operation of Drainage Allocations** implemented through combination waiver of WDRs, focused general WDRs, and MAA to address DMC discharges.

Each of the alternatives involves a different level of regulatory intervention and stringency with respect to discharges to the LSJR. The less stringent an alternative is the more discharge to the LSJR is allowed. Conversely, the more stringent an alternative is the less discharge to the LSJR is allowed and consequently more drainage must be retained and treated. Costs to discharges are proportional to the volume of drainage that must be managed. An estimate of the volume of drainage (and associated salt concentration) needing treatment for each alternative was developed in order to estimate the cost associated with each alternative. It was assumed that no additional drainage would be captured or treated under the No Action/ No Project alternative and therefore there are no additional cost discharges to implement Alternative 1. Drainage from the following five source types was considered for the three remaining alternatives:

1) Grassland subarea subsurface drainage
2) Grassland subarea surface drainage
3) Wetland drainage (surface)
4) Non-grassland subsurface drainage
5) Non-grassland surface drainage

Table D-3 shows the estimated mean annual drainage volumes needing treatment for each alternative. A description of the method used to estimate the drainage volumes needing treatment is provided in Section 3.4.7 of the staff report and in more detail in Appendix 5.

Table D-3: Estimated Mean Annual Volume of Drainage Needing Treatment

Source type	Wet Q (TAF)	Wet TDS (mg/L)	Above normal Q (TAF)	Above normal TDS (mg/L)	Below normal Q (TAF)	Below normal TDS (mg/L)	Dry Q (TAF)	Dry TDS (mg/L)	Critical Q (TAF)	Critical TDS (mg/L)
ALTERNATIVE 2: PROHIBITION										
Grassland subarea subsurface drainage	42	3,400	32	3,400	30	3,400	28	3,400	22	3,400
Grassland subarea surface drainage	60	630	60	630	60	630	60	630	60	630
Wetland drainage	132	1,000	132	1,000	132	1,000	132	1,000	132	1,000
Non-Grassland subsurface drainage	10	1,700	10	1,700	10	1,700	10	1,700	10	1,700
Non-Grassland surface drainage	270	390	270	390	270	390	270	390	270	390
Totals	**514**		**504**		**502**		**500**		**494**	
ALTERNATIVE 3: FIXED BASE LOAD TMDL										
Source type	Wet Q (TAF)	Wet TDS (mg/L)	Above normal Q (TAF)	Above normal TDS (mg/L)	Below normal Q (TAF)	Below normal TDS (mg/L)	Dry Q (TAF)	Dry TDS (mg/L)	Critical Q (TAF)	Critical TDS (mg/L)
Grassland subarea subsurface drainage	17	3,300	13	3,400	24	3,400	23	3,400	21	3,400
Grassland subarea surface drainage	29	460	29	460	40	601	48	650	53	640
Wetland drainage	9	1,000	9	1,000	43	1,000	47	1,000	77	1,000
Non-Grassland subsurface drainage	4	1,600	4	1,600	7	1,600	7	1,600	9	1,700
Non-Grassland surface drainage	121	390	130	390	130	390	147	380	204	380
Totals	**180**		**185**		**244**		**272**		**364**	
ALTERNATIVE 4A: REAL-TIME TMDL (no re-operation of drainage)										
Source type	Wet Q (TAF)	Wet TDS (mg/L)	Above normal Q (TAF)	Above normal TDS (mg/L)	Below normal Q (TAF)	Below normal TDS (mg/L)	Dry Q (TAF)	Dry TDS (mg/L)	Critical Q (TAF)	Critical TDS (mg/L)
Grassland subarea subsurface drainage	9	3400	8	3,400	18	3500	17	3,500	18	3,400
Grassland subarea surface drainage	0	--	2	430	10	640	13	670	30	570
Wetland drainage	0	--	14	1,000	9	1,000	17	1,000	31	1,000
Non-Grassland subsurface drainage	0	--	1	1,500	3	1,700	3	1,700	5	1,700
Non-Grassland surface drainage	0	--	0	--	6	370	2	400	34	380
Totals	**9**		**25**		**46**		**52**		**118**	

<u>Drainage Management Cost Information Sources:</u>

A Management Plan For Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley 1990, also known as the Rainbow Report, presented numerous implementation programs and projected cost estimates for various drainage management practices, however, many of those implementation concepts and cost estimates have been updated in more recent reports. Therefore none of the costs estimates from the Rainbow report were utilized. The Draft United States Bureau of Reclamation (USBR) Report *Plan Formulation Appendix, San Luis Unit Drainage Program* 1991, also provided detailed cost estimates and engineering design for remediation of drainage problem areas using a linked agricultural production/hydrology model, but those cost estimates were also a decade old and therefore not used. Cost estimates were used, however, from the USBR Report *San Luis Unit Drainage Feature Re-Evaluation Preliminary Alternatives Report* 2001, particularly for cost estimates for evaporation ponds and landfill disposal of salts. Rodney T. Smith's paper *The Economic Costs of Water Conservation and the Impact of Uncompensated Conservation on the Economic Viability of Farming in the Imperial Valley* offered the most up to date and extensive known costs for surface drainage (tailwater) recovery systems. Cost estimates for subsurface drainage (tilewater) recovery systems and reuse systems were based on oral communications with Chris Linneman of Summers Engineering.

Management Practice Cost Estimates:

Appendix 2 describes fourteen possible actions for managing or treating saline drainage. Several of these approaches have been undertaken on a short-term small scale (pilot or demonstration project), others strategies are only now in the formulative stages. Cost estimates for many of these types of treatment from various studies over the last several decades vary significantly. The economic analysis included a review of what was considered to be the most feasible management practices and treatment technologies. In some cases cost estimates were revised upward to be conservative. The costs estimates for seven management practices are summarized in Table D-4 and are discussed below.

Table D-4: Summary of Management Practice Costs and Anticipated Drainage Volume Reduction

Management Practice	Capital Costs	O & M Costs	Drainage Volume Reduction
Surface Drainage Re-circulation	$812/acre-foot	$55/acre-foot/year	15%
Subsurface Drainage Re-circulation	$250/acre-foot	$50/acre-foot/year	100%[1]
Sequential Drainage Re-use	$938/acre-foot	$200/acre-foot/year	47%
Evaporation Ponds	$340/acre-foot	$50/acre-foot/year	100%[2]
Temporary Retention Ponds (re-operation)	$315/acre-foot	$50/acre-foot/year	100%[4]
Real-time Management	$350,000/system[3]	$100,000/system[3]/year	100%[4]
Landfill Disposal Of Salts (cost per ton)	$200/ton	$25/ton	N/A

1-Assumes that 100% of surface drainage can be re-used.
2-100% of all drainage discharged to evaporation ponds will be permanently disposed.
3-11 systems are estimated to be needed to fully implement real-time management
4-100% of all drainage will either be discharged to the LSJR, re-operated, or discharged to evaporation ponds for permanent disposal.

Surface Drainage Re-circulation (Tail Water Recovery)

Surface drainage re-circulation is the collection and reuse of tail water to irrigate crops at the field, water district or regional scale. No irrigation system is 100% efficient and therefore surface irrigation water can be spilled at the "tail" end of the field(s). Surface drainage recovery and re-circulation involves the capture and reuse of that spilled water. In many cases one reuse is sufficient to use up the spilled water. Surface drainage re-circulation on the farm and district level is commonly used in many parts of the valley. The salt content of surface drainage depends on several factors including the initial salt content of the irrigation supply, soil salinity, irrigation methods, and evapotranspiration rates. We estimate that typical surface drainage discharges in the LSJR watershed have TDS concentration approximately ranging from 600 to 700 mg/L (CVWRQCB, 2003). We assume that 100 percent of the surface drainage needing treatment can be re-circulated and blended with supply water. This assumption is supported by the fact that some water districts in the San Joaquin Valley have already adopted zero surface drainage discharge policies.

The costs of drainage re-circulation of surface drainage per acre (or the recovery that can be pumped back and re-applied) depends on slope, soil type, antecedent soil moisture conditions, stage of crop growth and irrigation system design. A study on the economic costs of water conservation by installing permanent surface drainage return systems in the Imperial Valley reflect conserved water (water recovered or pumped back) can be as low as 0.16 acre-foot per acre to as high as 1.75 acre-foot per acre (Smith, 2002). The Imperial Valley study reported that the average recovery from 23 systems was 0.75 acre-foot per acre. Appendix 5 of salt and boron TMDL reported the average surface drainage spill for the Northwest subarea to be 1.16acre-foot per acre. Capital costs of installing surface drainage recovery systems range from $40/acre (rice surface drainage recovery systems installed in the 80's) to $963/acre (Smith, 2002) and operation and maintenance cost ranging from $42 to $78 per acre (Smith, 2002). The capital cost of installing a surface drainage recovery system for this analysis are based on the Imperial Valley Study that reported costs to average around $812 per acre-foot. Operation and maintenance costs are also used from the Imperial Valley Study (based on 23 systems). Operation and maintenance is estimated to be about $55 per acre-foot.

Subsurface Drainage Re-circulation (Tilewater Recovery)

Tilewater is subsurface irrigation water that is typically drained (using tile drains) and pumped by a sump or gravity fed to lower elevation canals. Most subsurface drainage that has migrated from the root zone to the tile drains is too saline to be directly reapplied to many crops. In many cases that water can be re-circulated and blended with less saline supply water to irrigate other fields. The USBR report "San Luis Unit Drainage Feature Re-Evaluation Plan formulation Report" on Table 3.3-1b (page 3-8) indicates that about 15% of the subsurface drainage can be blended and therefore reduced.

The costs of subsurface drainage recovery and re-circulation systems vary depending on the size and complexity of the system. Cost estimates for subsurface drainage re-circulation are based on the Panoche Drainage District model where total cost averaged about $100 per acre capital costs. Converting this number to acre-foot units (assuming 0.4 acre-feet per acre drains as tile water) results in a initial capital cost of $250 per acre-foot. Operation and maintenance is estimated to be about $50 per acre-foot. (Chris Linneman, personal communication)

<u>Sequential Reuse & Volume Reduction/IFDM (In Farm Drainage Management)</u>

Sequential reuse is the multiple use of irrigation water on progressively salt tolerant plants in order to concentrate and reduce volumes of saline water. Particularly if combined with ponds and water treatment methods, this approach will help reduce instantaneous peak loads of salt to the LSJR. Unless combined with salt disposal, however, this method is only a short-term remedy for salt loading to the LSJR because salts are still imported to and generated within the basin. Without consideration of where salt goes in the system, this method can lead to long-term degradation (salinization) of soils and groundwater. Groundwater degradation, in turn, will lead to increased long-term salt loading to the LSJR.

The USBR's "*San Luis Unit Drainage Feature Re-Evaluation Plan formulation Report*" (Table 3.3-1b, page 3-8) indicates that subsurface drainage volume can be reduced by approximately 50% through sequential re-use of drain water on increasingly more salt tolerant crops. The cost estimates given on pages B-18 and B-19 from the USBR's "*San Luis Unit Drainage Feature Re-Evaluation Preliminary Alternatives Report*" cites annual capital costs for tile drain and irrigation system installation to be $80 per acre-foot., annual operating costs were estimated to be $70 per acre-foot. These costs did not include the cost of land.

The cost estimates that we used for sequential re-use were: $2,500 per acre for land, $350 per acre for planting, $750 per acre for installation of shallow-dense tile systems, and $150 per acre for irrigation system installation (Chris Linneman, Personnel Communication). Resulting in a total cost of $3,750 per acre. Assuming that 4 acre-feet per acre of subsurface drainage can be applied annually to salt tolerant crops, the $3750 per acre cost can be converted to $938 per acre-foot (capital costs). Operation and maintenance is estimated to be approximately $200 per acre-foot for reuse systems.

<u>Evaporation Ponds/Retention Ponds</u>

The cost estimates that were used for evaporation ponds were taken directly from the USBR's "*San Luis Unit Drainage Feature Re-Evaluation Preliminary Alternatives Report*". A cost estimate is given in Table B-4 on page B-27 of that report. Cost estimates were developed for an evaporation pond facility that would encompass 1280 acres (approximately 1130 acres of pond surface). The construction costs shown in the Table include land acquisition, including the purchase of compensatory land (for bird habitat mitigation) on a 1:1 basis, earthwork, and fencing. The costs of a geomembrane liner and bird netting were not included. The operation and maintenance costs include maintenance, pumping power, and monitoring. This conceptual cost estimate does not include any additional costs associated with salt disposal or site closure. It should also be noted that this estimate could increase if treatment for selenium removal is required. The total capital costs are estimated to be $340 per acre-foot, which includes a 30% contingency cost. Operation and maintenance costs are estimated at $50 per acre-foot.

Real Time Management

Using real-time management dischargers would be responsible for forecasting the assimilative capacity in the LSJR and for coordinating discharges to the LSJR in a manner that maximizes discharges to the river while at the same time ensures that water quality objectives are met. The amount of drainage that would be allowed to be discharged to the river would generally exceed the amount that would be allowed under fixed base load allocations (as is the case for Alternative 3), significantly reducing the volume of drainage needing permanent treatment. This would result in reduced treatment costs associated with treating a smaller volume of drainage; however, additional capabilities would be needed to operate on real-time basis and not all of the drainage generated could always be discharged back to the LSJR. Some drainage would therefore still need to be permanently treated using the management practices described above.

In order to operate on a real-time basis additional monitoring facilities would be needed to characterize drainage flows and loads at a water district or regional scale. Enhanced monitoring equipment, modeling, and forecasting capability would be needed to forecast assimilative capacity in the LSJR. Control gates and conveyances systems would also be needed to divert drainage from river discharge to permanent treatment trains when assimilative capacity was not available. Personnel would be needed to manage real-time systems and coordinate discharges from multiple subareas in the LSJR watershed.

A typical real time system could include the following components and costs: computer and software at $5,000 per system, 10 control gates with an estimated cost of $100,000 per system, floats, weirs, EC monitoring equipment at $50,000 per system, installation at a cost of $75,000 per system, conveyance systems to river costing $100,000 per system, plus a $20,000 per system contingency cost**.** Total capital costs are estimated to be $350,000 per system. Operation and maintenance costs (including discharge coordination) are estimated at $100,000 per year per system. Initial cost estimates assume that eleven systems would cover most of the major irrigation districts and the wetland operations in the LSJR. These cost estimates are based on professional judgment.

Real Time Management with Drainage Re-operation

Drainage re-operation is an extension of real-time management that is intended to further reduce the amount of drainage needing permanent treatment. Re-operation of drainage involves holding back saline discharges when no assimilative capacity is available (no real-time load allocation is available) then discharging those retained salts at a later time when assimilative capacity is available (higher flow periods). The concept is similar to real-time management as described above except that drainage that exceeds real-time load allocations is diverted to temporary retention ponds (for later release) instead of to permanent treatment. Temporary retention ponds would contain EC and flow monitoring equipment. Gates could be installed in conjunction with conveyance systems that could deliver water to the LSJR. Concentration levels of salts in the main stream of the LSJR would be monitored on a real time basis. The volumes and the concentrations of salts in the ponds would be known, as well as the total number of systems in the Lower San Joaquin Basin. We assume that the subsurface drainage from the Grassland subarea would not be re-operated due to concerns regarding elevated selenium concentrations. Grassland subsurface drainage would therefore require permanent treatment.

Re-operation of drainage would require all of the same components and costs associated with real-time management. Additionally, temporary retention ponds would be needed to retain drainage during times of limited assimilative capacity. We estimate that the maximum volume drainage needing to be temporally stored would not exceed 50 TAF during any given year and that no multi-year carryover would be needed (again assuming that Grassland subsurface drainage would always be permanently treated and not re-operated).

Temporary retention ponds could be designed similar to the prototypes listed in the USBR Preliminary Assessment Report and therefore the per acre-foot costs estimates to build and operate temporary retention ponds for drainage re-operation are the same as the estimates for evaporation ponds (described above). The only exception is that compensatory mitigation habitat would not be required for the temporary retention ponds because they would not receive drainage with high selenium concentrations and long-term bioaccumation or evapoconcentration should not be a problem since the ponds will be drained at least once a year. The total capital costs are estimated to be $315 per acre-foot of drainage ($340 per acre-foot less the cost of compensatory mitigation), which includes a 30% contingency cost. The projected annual cost for real-time management and drainage re-operation is shown in Table D-5. Operation and maintenance costs are estimated at $50 per acre-foot. The cost to build and operate temporary retention ponds, however, would be offset by the reduced costs for permanent treatment.

Table D-5: Cost Estimates for Real-time Management and Drainage Re-operation

REAL-TIME MANAGEMENT COSTS				
	# of Systems	costs per system	Sub total	Annual costs
Equipment Capital Costs	11	$350,000	$3,850,000	$335,661[1]
O&M costs	11	$100,000	$1,100,000	$1,100,000
			Total Annual Real-time Costs	**$1,435,661**
DRAINAGE RE-OPERATION COSTS				
	Storage Volume	Cost/acre-foot	Sub total	Annual costs
Retention Pond Capital Costs	50,000	$315	$15,750,000	$1,373,157[1]
Pond O&M costs	50,000	$50	$2,500,000	$2,500,000
			Total Annual Re-operation Costs	**$3,873,157**
			Total Estimated Annual Combined Costs	**$5,308,817.32**
1- Capital costs amortized over 20 years at a 6% annual interest rate				

Landfill Disposal

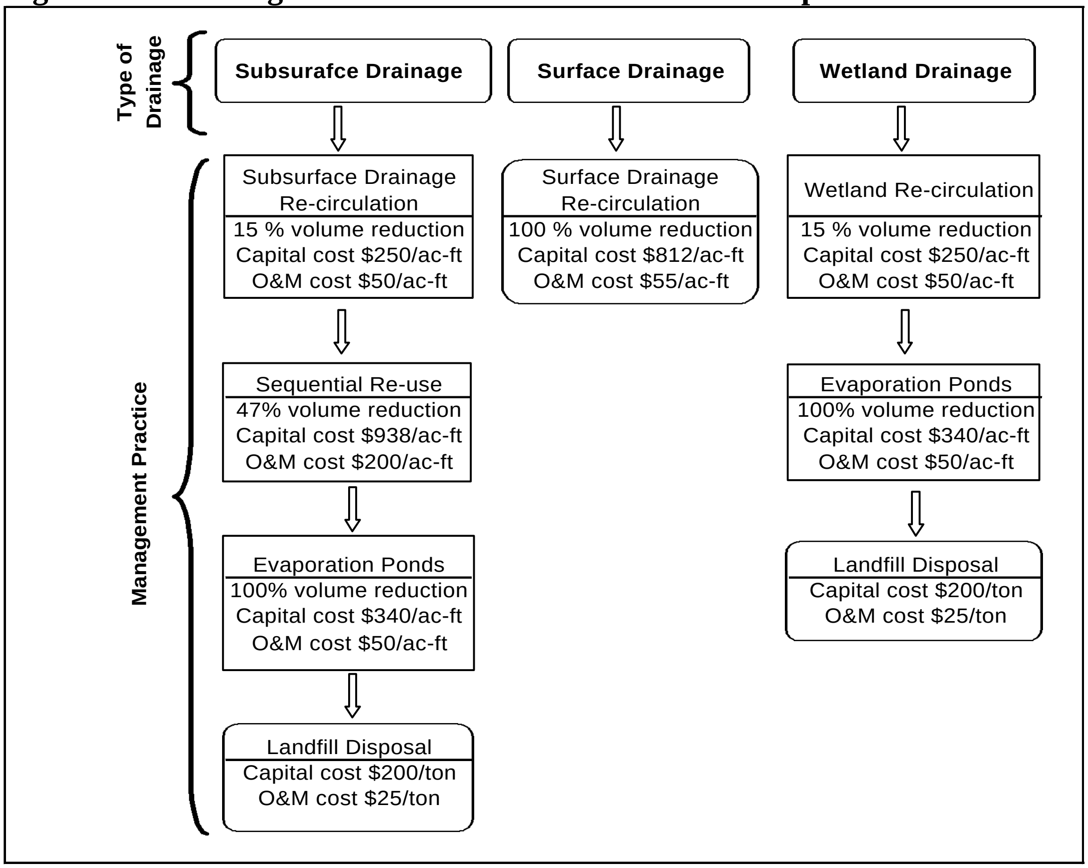
The costs of storing salts and trace constituents that the USBR published in the "San Luis Unit Drainage Feature Re-Evaluation Preliminary Alternatives Report" were estimated to be $20 per ton tipping fee to a Class II landfill and $100 per ton hauling cost. It is estimated that salts could be stored in concentrated evaporation ponds up to 50 years before the salt would have to be hauled off to landfills. To be conservative the total capital cost estimate for salt disposal was estimated at $200 per ton. Operation and maintenance is estimated to be about $25 per ton.

Calculation of Cost Estimates for Each Alternative:

Calculation of the cost estimates is based on the volume of drainage needing treatment under four different implementation alternatives described in section 3.4.6 of the staff report. The volumes of drainage needing treatment vary with the degree of regulatory control proposed by each alternative. The existing volume of drainage and associated salt loads was estimated so that each alternative could be evaluated. For example, a full prohibition of discharge (Alternative 2) would require retention or treatment of all of the drainage being generated in the LSJR and therefore an estimate of the amount of drainage being generated is needed.

The general approach for developing cost estimates involved running the estimated volumes of drainage needing treatment through a series of management practices, whereby drainage volume was reduced at each stage of the treatment process. Three different treatment scenarios were used to address subsurface agricultural drainage, surface agricultural drainage, and wetland drainage (Figure D-1). A cost per acre-foot of drainage treated is applied to each management practice used and costs accrue at each stage of the treatment/management cycle until salts are ultimately disposed of in landfills or released to the LSJR (as is the case for re-operation of drainage). Stepwise calculation of cost estimates for each alternative and each water-year type are provided in Attachment 1. These cost estimates are summarized in Table D-6.

Figure D-1: Drainage Treatment Scenarios Used to Develop Cost Estimates



As mentioned above, the mean annual drainage was quantified to estimate the existing volume of drainage being generated from the following five source types; (1) Grassland subarea agricultural subsurface drainage; (2) Grassland subarea agricultural surface drainage; (3) Wetland drainage; (4) Non-grassland agricultural subsurface drainage; and (5) Non-grassland agricultural surface drainage. The methods used to estimate the drainage flows and salt loads from these five sources are given in Appendix 5. Annual estimates of the volume of drainage needing treatment are based, in part, on estimates of the mean monthly drainage volumes and drainage salt loads. Treatment facilities, however, must be designed to handle the volume of drainage in any given year, including years when annual drainage volumes exceed the mean.

In order to be conservative and account for high drainage conditions, a ratio of the mean drainage flows and salt loads to the maximum drainage flows and salt loads was developed and applied to the cost estimates. The ratio of the mean volume of drainage generated to the maximum volume of drainage generated from the five sources types is estimated to be approximately 1.4. The ratio of the mean salt load generated to the maximum drainage salt load generated from the five sources types is estimated to be approximately 1.3. A coefficient 1.4 was applied to all of the cost estimates to provide a range of costs associated with each implementation alternative, including the cost of implementation during high drainage producing years. The annual cost estimates for each implementation alternative are given in Table D-6.

Table D-6. Summary of Annual Cost Estimates for Implementation Alternatives

Alt. #	Description	Most Restrictive Water Year Type [1]	Total Annual Cost of Implementation ($ Million)
1	No Action	N/A	0
2	Prohibition of Discharge	Wet	95-133
3	Base Load TMDL	Critical	63-88
4a	Real-time TMDL (no re-operation)	Below Normal	27-38
4b	Real-time TMDL with Re-operation	Below Normal	15-21
1-The most restrictive water year type is the water year type for which the highest costs will be incurred because the highest volume of drainage needs to be retained and treated.			

The cost estimates shown in Table D-6 represent high cost estimates because high values for the cost per unit volume of drainage treatment were used to be conservative. Furthermore, the volume of drainage requiring treatment varies by water year type for each alternative evaluated. For example a wet year is the most restrictive water year type for Alternative 2 (full prohibition of discharge). This is because the highest volume of drainage is produced during wet years and under a full prohibition all drainage must be retained and treated. In contrast, a critical water year is the most restrictive year type for Alternative 3 (base TMDL allocation) because the base TMDL allows only minimal discharge to the LSJR during critical years (the volume of drainage needing treatment is equal to the total volume of drainage generated minus the volume drainage that can be discharged to the LSJR). The cost estimates given in Table D-6 are for the most restrictive year types associated with each alternative. Most of the time, however, the actual year type will not be the most restrictive year type since there are five different year types that can potentially occur. Annual implementation costs will presumably decrease during less restrictive year types. The costs presented here should therefore be considered to be conservative.

The treatment scenarios/processes used to develop cost estimates only represent one potential approach for addressing saline drainage. These treatment scenarios are limited and are based on the use of some of the more proven technologies available for the drainage management. Dischargers will actually be free to use any drainage treatment method that results in compliance with the control program; therefore, the actual costs of compliance will vary.

III. EXISTING AGRICULTURAL PRODUCTION COSTS IN THE LSJR WATERSHED

The goal of this section is to estimate the existing cost of agricultural production in the LSJR watershed. This cost estimate can be used to evaluate any "new" costs associated with the implementation of a proposed salt and boron control program relative to the existing/ongoing costs of agricultural production. The cost estimates for selected crops in LSJR watershed are based on information from the California Department of Water Resources (DWR) and the U.C. Cooperative Extension (UCCE). DWR land use survey data are used to identify the largest crops (by area) in the LSJR watershed and estimate the acreage grown for each identified crop (DWR, 2001). Cost estimates for the production of each crop type are derived from UCCE Costs and Returns Studies, which are available at http://www.coststudies.ucdavis.edu/. The cost for the production of each crop is calculated by multiplying the cost per acre from the UCCE data by the acreage of each crop as determined using GIS analysis of the DWR land use data. The total existing cost of agricultural production in the LSJR watershed is equal to the sum of the costs for each crop type.

Calculation of Crop Acreages

Land use data from the DWR obtained on CD as GIS coverages was used as the basis to determine largest crops (by area) in the LSJR. GIS coverages for the counties of Fresno (1994), Madera (1995), Merced (1995), San Joaquin (1996), and Stanislaus (1996) were tiled together and clipped to the boundary of the LSJR watershed. Areas for each record in the resultant Polygon Attribute Table (PAT) were exported to a spreadsheet. Each PAT record was summed by crop to determine total area of each crop type delineated by DWR (Table D-7).

Table D-7: Largest Crops (by acreage) in the LSJR by area

Crop	Thousand Acres	Percent of Total Agricultural Land Use
Almonds	230	16.1%
Cotton	205	14.3%
Alfalfa & alfalfa mixtures	168	11.8%
Mixed pasture	130	9.1%
Unclassified vineyards	127	8.9%
Corn (field & sweet)	126	8.8%
Unclassified grain and hay crops	88	6.2%
Tomatoes	50	3.5%
Beans (dry)	42	2.9%
Walnuts	40	2.8%
Melons, squash, and cucumbers (all types)	33	2.3%
Unclassified field crops	28	2.0%
Pistachios	26	1.8%
Peaches and nectarines	20	1.4%
Figs	14	1.0%
Rice	13	0.9%
Sugar beets	13	0.9%
Apricots	12	0.8%
All other crops	64	4.5%
Total of all crops	1,429	100%

The crop types delineated in the DWR land use surveys do not exactly match the crop types evaluated in UCCE cost and return studies. As a result, some professional judgment was used to match crop types delineated in the DWR land use data to the crop types evaluated in the UCCE cost estimates.

The UCCE differentiated crops by geographic location and in some cases, by variety. The preferred geographic regions used for UCCE production costs were for the San Joaquin Valley or San Joaquin Valley – North. In five cases, however, top crops identified from the DWR land use data did not have corresponding UCCE cost data for the San Joaquin Valley. In these instances, the most reasonable alternative geographic region available was selected instead. These alternative geographic regions included San Joaquin Valley – South, Sacramento Valley, and the Imperial Valley.

Geography was not the only factor considered in the matching process. In some cases, the land use categories given to different crop types by the DWR did not match those of theUCCE. In another case, the UCCE supplied multiple varieties of the same commodity whereas the DWR land use data was more generic. There are three instances where the most logical alternative available was used due to a lack of a definitive match between the DWR land use data and the UCCE agricultural cost studies. For the DWR land use classification of "Melons, squash, and cucumbers (all types)," the UCCE classifications of “Mixed melons” and “Watermelons” were used for the mean costs. For the land use classification of “Unclassified field crops,” the UCCE classification of “Winter forage” was used. For the land use classification of “Unclassified grain and hay crops”, the UCCE classification of “Wheat silage” was used. These matches are not exact, but considered the best alternatives.

Apricots were the one top crop designated in the DWR land use data that lacked a match in the UCCE data. Since no data was available for apricots, the costs associated with peaches/nectarines were used to represent the costs for apricots.

Crop Production Cost Estimates (existing/ongoing)
The UCCE Cost and Return Studies for each crop provided costs associated with establishing a crop and bringing it to production age, producing a crop from year to year, breakdowns of operating costs, and cross-reference tables of net revenue based on a crop yield and price per unit. The data used for this study was that detailing the costs per acre to produce a given commodity. The data for the costs per acre to produce a commodity include Cultural Costs, Harvests Costs, sometimes a pre- or post- Harvest Cost, Cash Overhead Costs, Non-Cash Overhead Costs, and Assessment Cost.

The total cost for each of the above-listed categories was used to determine a total cost to produce a commodity. The exception is the Non-Cash Overhead Costs category, which was not used. Establishment Costs from the Non-Cash Overhead Costs category was used, however. The Establishment Costs consider the costs incurred during the unproductive young period in the life of many tree crops spread out over the average productive life of a crop. This cost, combined with the costs of the other categories creates an estimate of the total cost of production for a given crop based on the UCCE data.

Calculation of LSJR Watershed Total Crop Costs

In eleven of the eighteen instances, there were multiple commodities from the UCCE data that matched a single crop type(s) from the DWR land use classifications. In most cases, multiple matches were as a result of UCCE data supplying data for multiple varieties of a single crop type. Since the amount of each variety grown within the LSJR watershed is not discernable from the DWR land use data, cost ranges were generated for some crops. The low end of the range was determined by multiplying the lowest production cost of a particular variety of a given crop by the acreage of that crop. The high end of the range was determined in much the same way except that we multiplied the production cost by the crop variety with the highest production cost. For example, the DWR land use data specifies Tomatoes as single crop type. The UCCE, however, provides cost estimates for both Processing Tomatoes (at approximately $1365 per acre) and Fresh Market Tomatoes (at approximately $5096 per acre). A high cost estimate for Tomatoes is based on a production cost of $5096 per acre and a low cost estimate is based on a production cost of $1365 per acre. In order to create an average cost for each crop, all of the production costs for all of the different varieties of each crop type were averaged together.

For the purposes of this analysis, the largest crops in the LSJR Watershed were determined to be those that accounted for at least 95% of the agricultural land use in the LSJR Watershed (Table D-7). The remaining five percent (approximate) of agricultural area that was not considered on a crop specific basis was categorized as “other crops”. This category comprises the crops not included on an individual basis from the DWR land use data. For the sake of completeness, an estimate of the total cost of production for remaining five percent was needed, since the 75,000 acres it represents is relatively small, but not insignificant.

A high end cost estimate, low end cost estimate, and average cost estimate for the other crops category as a whole was created based on the cost of production data for the crops that were considered on a crop specific basis. In each of the three cases, the cost for the eighteen crops that were evaluated was averaged together to create an average cost for the “other crops” as a whole. This value was then multiplied by the acreage of the unaccounted agriculture in the LSJR watershed to create a value representing total cost of production for the other crops category. This step assumes that the eighteen crops evaluated are an appropriate cross-section of all the crops grown in the LSJR watershed.

<u>Summary of Existing/Ongoing Agricultural Production Costs in the LSJR Watershed</u>

The goal of this cost analysis is to estimate the annual costs for existing ongoing agricultural production in the LSJR watershed. To accomplish this, the acreages of each crop were multiplied by their respective production cost (Table D-8). The average cost for agricultural production in the LSJR watershed was calculated by simply summing together the total average cost of production for each crop (including the “other crops”). The cost of production for each crop was also summed using both the high-end and low-end values for each crop to develop cost range. Using this method we estimate the mean annual cost of agricultural production in the LSJR to range from approximately 1.8 to 2.5 billion dollars per year.

Table D-8: Cost Estimates for Agricultural Production in the LSJR Watershed.

Crop	Thousand Acres	Low Cost		Mean Cost		High Cost	
		Per acre	Subtotal (million $)	Per acre	Subtotal (million $)	Per acre	Subtotal* (million $)
Almonds	230	$1,965	$453	$2,018	$465	$2,070	$477
Cotton	205	$767	$158	$799	$164	$838	$172
Alfalfa & alfalfa mixtures	168	$584	$98	$698	$117	$811	$136
Mixed pasture	130	$331	$43	$331	$43	$331	$43
Unclassified vineyards	127	$2,008	$255	$2,660	$338	$3,311	$420
Corn (field & sweet)	126	$659	$83	$799	$101	$943	$119
Unclassified grain and hay crops	88						
Tomatoes	50	$235	$21	$235	$21	$235	$21
Beans (dry)	42	$1,365	$68	$3,231	$160	$5,096	$253
Walnuts	40	$798	$33	$817	$34	$836	$35
Melons, squash, and cucumbers (all types)	33	$2,039	$75	$2,039	$75	$2,039	$75
Unclassified field crops	28	$5,383	$179	$5,536	$184	$5,689	$189
Pistachios	26						
Peaches and nectarines	20	$409	$11	$409	$11	$409	$11
Figs	14	$2,069	$53	$2,069	$53	$2,069	$53
Rice	13	$3,117	$62	$6,664	$133	$10,211	$203
Sugar beets	13	$1,087	$15	$1,184	$16	$1,277	$17
Apricots	12	$819	$11	$819	$11	$819	$11
All other crops	64	$1,202	$16	$1,202	$16	$1,202	$16
TOTAL COSTS		**$1.8 billion**		**$2.2 billion**		**$2.5 billion**	

IV. Potential Sources of Financing

The sources of funding identified in the Basin Plan for the agricultural subsurface drainage program and rice pesticide program are also potential funding sources for this program. These sources include:

1. Private financing by individual sources.
2. Bonded indebtedness or loans from government institutions.
3. Surcharge on water deliveries to lands contributing to the drainage problem.
4. Ad Valorem tax on lands contributing to the drainage problem.
5. Taxes and fees levied by a district created for the purpose of drainage management.
6. State or federal grants or low-interest loan programs.

7. Single purpose appropriations from federal or state legislative bodies (including land retirement programs).

Specific state and federal grant and loan programs include:

- USDA Environmental Quality Incentive Program (EQIP) grants, administered by the Natural Resources Conservation Service (NRCS).
- Consolidated grant program administered by the State Water Board, including Proposition 13 Nonpoint Source Pollution (NPS) Control program grants, 319 NPS Implementation Program grants, Proposition 13 CalFed Watershed program grants and Proposition 50 CalFed Watershed Program.
- State Revolving Fund Loan program for sources of NPS pollution.

V. SUMMARY

Implementation of a control program for salt and boron discharges to the LSJR will require significant expenditures from farmers and wetland operators. Alternative 4 is estimated to be the least expensive alternative to implement because drainage management needs are minimized and allowable discharges to the Lower San Joaquin River are maximized through real-time water quality management. We estimate that implementation of Alternative 4 will cost approximately 27 to 38 million dollars per year. Spreading this cost out over the 1.1 million acres of nonpoint source land use in the LSJR watershed results in cost of $25 to35 per acre per year. The economic analysis indicates that cost to dischargers can be further reduced if dischargers implement re-operation of drainage along with real-time management. Implementation of drainage re-operation should bring the total cost of implementation down to the 15 to 21 million dollar a year range or $14 to19 per acre per year.

We estimate the current cost of agricultural production in the LSJR watershed to be approximately 2.2 billion per year. These costs include the cost for equipment, irrigation, water, planting, land preparation, application of fertilizers, pest management, harvesting costs, and others. **The cost to implement Alternative 4a (real-time management <u>without</u> re-operation) would amount to an estimated 2 percent increase to the current cost of agricultural production in the entire LSJR watershed.** While this cost increase may seem relatively modest, it’s important to note that this is just the cost to implement one control program. Farmers may be faced with additional costs in the near future to implement other control programs for the control of pesticides, oxygen demanding substances, and other pollutants. Costs to implement controls for other pollutants may be additive. Furthermore, information provided in UCCE Costs and Returns Studies indicate that some of the major crops grown in the LSJR are not profitable because costs often exceed revenues. Adding additional costs to marginally profitable or unprofitable agricultural operations will be detrimental to agricultural interests in the LSJR watershed. However, we have strived to develop and recommend a program of implementation that will result attainment of water quality objectives and minimize costs by providing discharges with maximum flexibility and opportunity to discharge.

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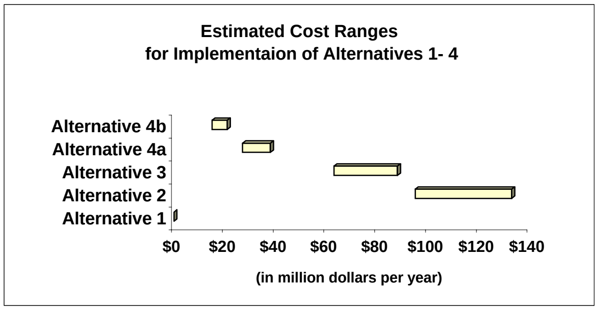
Attachment 1 - Calculation of Cost Estimates

Summary of Estimated Implementation Costs ($million/year)

Alternative	Description	Wet		Above Normal		Below Normal		Dry		Critical	
		Mean Cost	High Cost[1]	Mean Cost	High Cost[1]	Mean Cost	High Cost[1]	Mean Cost	High Cost[1]	Mean Cost	High Cost[1]
Alternative 1	No Action	0	0	0	0	0	0	0	0	0	0
Alternative 2	Prohibition of Discharge	95	133	89	125	88	123	87	122	84	118
Alternative 3	Base Load TMDL	32	45	31	43	46	64	49	69	63	88
Alternative 4a	Real-time TMDL	6	8	9	13	16	22	17	24	27	38
Alternative 4b	Real-time TMDL with re-operation	10	14	10	14	15	21	10	14	15	21

1-High cost equals mean cost times a factor of 1.4 which is applied to account for high flow conditions see Appendix D pages D13-D14 for full explanation.



Attachment 1 - Calculation of Cost Estimates

Alternative 2-Prohibition of Discharge Wet Year										
Drainage Source	**Management Practice**	**Drainage Volume (TAF)**	**Conc. (mg/L**	**Load (Tons)**	**O&M Cost (per acre-ft)**	**Capital Cost (per acre-ft)**	**Tot. Capital Cost**	**Annual Capital Costs[1]**	**Annual O&M Cost**	**Total Annual Costs**
Grassland Subsurface Drainage	Tile Drainage Re-circulation	**42** 15 % Vol. Reduction ↓	3,400	194,137	$50	$250	$10,500,000	$915,438	$2,100,000	$3,015,438
	Drainage Re-use	**36** 47 % Vol. Reduction ↓	4,000	194,137	$200	$938	$33,486,600	$2,919,514	$7,140,000	$10,059,514
	Evaporation Ponds	**19** 100 % Vol. Reduction ↓	7,547	194,137	$50	$340	$6,433,140	$560,870	$946,050	$1,506,920
	Landfill Disposal (cost per ton)	0	n/a	194,137	$25	$200	$38,827,320	$3,385,143	$4,853,415	$8,238,558
	Grassland Subsurface Drainage Wet Year Subtotal									**$22,820,430**
Grassland Surface Drainage	Surface Drainage Re-circulation	**60** 100 % Vol. Reduction	630	51,389	$55	$812	$48,720,000	$4,247,632	$3,300,000	$7,547,632
	Grassland Surface Drainage Wet Year Subtotal									**$7,547,632**
Wetland	Wetland Drainage Re-circulation	**132** 15 % Vol. ↓	1,000	179,454	$50	$250	$33,000,000	$2,877,090	$6,600,000	$9,477,090
	Evaporation Ponds	**112** 100 % Vol. Reduction ↓	1,176	179,454	$50	$340	$38,148,000	$3,325,916	$5,610,000	$8,935,916
	Landfill Disposal (cost per ton)	0	n/a	179,454	$25	$200	$35,890,800	$3,129,123	$4,486,350	$7,615,473
	Wetland Wet Year Subtotal									**$26,028,480**
Non-Grassland Tile	Tile Drainage Re-circulation	**10** 15 % Vol. Reduction ↓	1,700	23,112	$50	$250	$2,500,000	$217,961	$500,000	$717,961
	Drainage Re-use	**9** 47 % Vol. Reduction ↓	2,000	23,112	$200	$938	$7,973,000	$695,122	$1,700,000	$2,395,122
	Evaporation Ponds	**5** 100 % Vol. Reduction ↓	3,774	23,112	$50	$340	$1,531,700	$133,541	$225,250	$358,791
	Landfill Disposal (cost per ton)	**0**	n/a	23,112	$25	$200	$4,622,300	$402,993	$577,788	$980,781
	Non-Grassland Subsurface Drainage Wet Year Subtotal									**$4,452,655**
Non-Grassland Surface Drainage	Surface Drainage Re-circulation	**270** 100 % Vol. Reduction	390	143,155	$55	$812	$219,240,000	$19,114,342	$14,850,000	$33,964,342
	Non-Grassland Surface Drainage Wet Year Subtotal									**$33,964,342**

1=amortized over 20-years at 6% annual interest rate

Wet Year Annual Total Estimated Costs for Alternative 1-Prohibition of Discharge **$94,813,540**

Attachment 1 - Calculation of Cost Estimates

Alternative 2-Prohibition of Discharge Above Normal Year

Drainage Source	Management Practice	Drainage Volume (TAF)	Conc. (mg/L	Load (Tons)	O&M Cost (per acre-ft)	Capital Cost (per acre-ft)	Tot. Capital Cost	Annual Capital Costs[1]	Annual O&M Cost	Total Annual Costs
Grassland Subsurface Drainage	Tile Drainage Re-circulation	**32** 15 % Vol. Reduction ↓	3,400	147,914	$50	$250	$8,000,000	$697,476	$1,600,000	$2,297,476
	Drainage Re-use	**27** 47 % Vol. Reduction ↓	4,000	147,914	$200	$938	$25,513,600	$2,224,392	$5,440,000	$7,664,392
	Evaporation Ponds	**14** 100 % Vol. Reduction ↓	7,547	147,914	$50	$340	$4,901,440	$427,330	$720,800	$1,148,130
	Landfill Disposal (cost per ton)	0	n/a	147,914	$25	$200	$29,582,720	$2,579,156	$3,697,840	$6,276,996
									Grassland Subsurface Drainage Above Normal Year Subtotal	**$17,386,995**
Grassland Surface Drainage	Surface Drainage Re-circulation	**60** 100 % Vol. Reduction	630	51,389	$55	$812	$48,720,000	$4,247,632	$3,300,000	$7,547,632
									Grassland Surface Drainage Above Normal Year Subtotal	**$7,547,632**
Wetland	Wetland Drainage Re-circulation	**132** 15 % Vol. ↓	1,000	179,454	$50	$250	$33,000,000	$2,877,090	$6,600,000	$9,477,090
	Evaporation Ponds	**112** 100 % Vol. Reduction ↓	1,176	179,454	$50	$340	$38,148,000	$3,325,916	$5,610,000	$8,935,916
	Landfill Disposal (cost per ton)	0	n/a	179,454	$25	$200	$35,890,800	$3,129,123	$4,486,350	$7,615,473
									Wetland Above Normal Year Subtotal	**$26,028,480**
Non-Grassland Subsurface Drainage	Tile Drainage Re-circulation	**10** 15 % Vol. Reduction ↓	1,700	23,112	$50	$250	$2,500,000	$217,961	$500,000	$717,961
	Drainage Re-use	**9** 47 % Vol. Reduction ↓	2,000	23,112	$200	$938	$7,973,000	$695,122	$1,700,000	$2,395,122
	Evaporation Ponds	**5** 100 % Vol. Reduction ↓	3,774	23,112	$50	$340	$1,531,700	$133,541	$225,250	$358,791
	Landfill Disposal (cost per ton)	**0**	n/a	23,112	$25	$200	$4,622,300	$402,993	$577,788	$980,781
									Non-Grassland Subsurface Drainage Above Normal Year Subtotal	**$4,452,655**
Non-Grassland Surface Drainage	Surface Drainage Re-circulation	**270** 100 % Vol. Reduction	390	143,155	$55	$812	$219,240,000	$19,114,342	$14,850,000	$33,964,342
									Non-Grassland Surface Drainage Above Normal Year Subtotal	**$33,964,342**

1=amortized over 20-years at 6% annual interest rate

Above Normal Year Annual Total Estimated Costs for Alternative 1-Prohibition of Discharge **$89,380,104**

Attachment 1 - Calculation of Cost Estimates

Alternative 2-Prohibition of Discharge Below Normal Year										
Drainage Source	Management Practice	Drainage Volume (TAF)	Conc. (mg/L	Load (Tons)	O&M Cost (per acre-ft)	Capital Cost (per acre-ft)	Tot. Capital Cost	Annual Capital Costs[1]	Annual O&M Cost	Total Annual Costs
Grassland Subsurface Drainage	Tile Drainage Re-circulation	**30** 15 % Vol. Reduction ↓	3,400	138,669	$50	$250	$7,500,000	$653,884	$1,500,000	$2,153,884
	Drainage Re-use	**26** 47 % Vol. Reduction ↓	4,000	138,669	$200	$938	$23,919,000	$2,085,367	$5,100,000	$7,185,367
	Evaporation Ponds	**14** 100 % Vol. Reduction ↓	7,547	138,669	$50	$340	$4,595,100	$400,622	$675,750	$1,076,372
	Landfill Disposal (cost per ton)	0	n/a	138,669	$25	$200	$27,733,800	$2,417,959	$3,466,725	$5,884,684
	Grassland Subsurface Drainage Below Normal Year Subtotal									**$16,300,307**
Grassland Surface Drainage	Surface Drainage Re-circulation	**60** 100 % Vol. Reduction	630	51,389	$55	$812	$48,720,000	$4,247,632	$3,300,000	$7,547,632
	Grassland Surface Drainage Below Normal Year Subtotal									**$7,547,632**
Wetland	Wetland Drainage Re-circulation	**132** 15 % Vol. ↓	1,000	179,454	$50	$250	$33,000,000	$2,877,090	$6,600,000	$9,477,090
	Evaporation Ponds	**112** 100 % Vol. Reduction ↓	1,176	179,454	$50	$340	$38,148,000	$3,325,916	$5,610,000	$8,935,916
	Landfill Disposal (cost per ton)	0	n/a	179,454	$25	$200	$35,890,800	$3,129,123	$4,486,350	$7,615,473
	Wetland Below Normal Year Subtotal									**$26,028,480**
Non-Grassland Subsurface Drainage	Tile Drainage Re-circulation	**10** 15 % Vol. Reduction ↓	1,700	23,112	$50	$250	$2,500,000	$217,961	$500,000	$717,961
	Drainage Re-use	**9** 47 % Vol. Reduction ↓	2,000	23,112	$200	$938	$7,973,000	$695,122	$1,700,000	$2,395,122
	Evaporation Ponds	**5** 100 % Vol. Reduction ↓	3,774	23,112	$50	$340	$1,531,700	$133,541	$225,250	$358,791
	Landfill Disposal (cost per ton)	**0**	n/a	23,112	$25	$200	$4,622,300	$402,993	$577,788	$980,781
	Non-Grassland Subsurface Drainage Below Normal Year Subtotal									**$4,452,655**
Non-Grassland Surface Drainage	Surface Drainage Re-circulation	**270** 100 % Vol. Reduction	390	143,155	$55	$812	$219,240,000	$19,114,342	$14,850,000	$33,964,342
	Non-Grassland Surface Drainage Below Normal Year Subtotal									**$33,964,342**

1=amortized over 20-years at 6% annual interest rate

Below Normal Year Annual Total Estimated Costs for Alternative 1-Prohibition of Discharge **$88,293,417**

Attachment 1 - Calculation of Cost Estimates

Alternative 2-Prohibition of Discharge Dry Year										
Drainage Source	**Management Practice**	**Drainage Volume (TAF)**	**Conc. (mg/L**	**Load (Tons)**	**O&M Cost (per acre-ft)**	**Capital Cost (per acre-ft)**	**Tot. Capital Cost**	**Annual Capital Costs[1]**	**Annual O&M Cost**	**Total Annual Costs**
Grassland Subsurface Drainage	Tile Drainage Re-circulation	**28** 15 % Vol. Reduction ↓	3,400	129,424	$50	$250	$7,000,000	$610,292	$1,400,000	$2,010,292
	Drainage Re-use	**24** 47 % Vol. Reduction ↓	4,000	129,424	$200	$938	$22,324,400	$1,946,343	$4,760,000	$6,706,343
	Evaporation Ponds	**13** 100 % Vol. Reduction ↓	7,547	129,424	$50	$340	$4,288,760	$373,914	$630,700	$1,004,614
	Landfill Disposal (cost per ton)	0	n/a	129,424	$25	$200	$25,884,880	$2,256,762	$3,235,610	$5,492,372
	Grassland Subsurface Drainage Dry Year Subtotal									**$15,213,620**
Grassland Surface Drainage	Surface Drainage Re-circulation	**60** 100 % Vol. Reduction	630	51,389	$55	$812	$48,720,000	$4,247,632	$3,300,000	$7,547,632
	Grassland Surface Drainage Dry Year Subtotal									**$7,547,632**
Wetland	Wetland Drainage Re-circulation	**132** 15 % Vol. Reduction ↓	1,000	179,454	$50	$250	$33,000,000	$2,877,090	$6,600,000	$9,477,090
	Evaporation Ponds	**112** 100 % Vol. Reduction ↓	1,176	179,454	$50	$340	$38,148,000	$3,325,916	$5,610,000	$8,935,916
	Landfill Disposal (cost per ton)	0	n/a	179,454	$25	$200	$35,890,800	$3,129,123	$4,486,350	$7,615,473
	Wetland Dry Year Subtotal									**$26,028,480**
Non-Grassland Subsurface Drainage	Tile Drainage Re-circulation	**10** 15 % Vol. Reduction ↓	1,700	23,112	$50	$250	$2,500,000	$217,961	$500,000	$717,961
	Drainage Re-use	**9** 47 % Vol. Reduction ↓	2,000	23,112	$200	$938	$7,973,000	$695,122	$1,700,000	$2,395,122
	Evaporation Ponds	**5** 100 % Vol. Reduction ↓	3,774	23,112	$50	$340	$1,531,700	$133,541	$225,250	$358,791
	Landfill Disposal (cost per ton)	**0**	n/a	23,112	$25	$200	$4,622,300	$402,993	$577,788	$980,781
	Non-Grassland Subsurface Drainage Dry Year Subtotal									**$4,452,655**
Non-Grassland Surface Drainage	Surface Drainage Re-circulation	**270** 100 % Vol. Reduction	390	143,155	$55	$812	$219,240,000	$19,114,342	$14,850,000	$33,964,342
	Non-Grassland Surface Drainage Dry Year Subtotal									**$33,964,342**

1=amortized over 20-years at 6% annual interest rate

Dry Year Annual Total Estimated Costs for Alternative 1-Prohibition of Discharge **$87,206,730**

Attachment 1 - Calculation of Cost Estimates

Alternative 2-Prohibition of Discharge Critical Year										
Drainage Source	**Management Practice**	**Drainage Volume (TAF)**	**Conc. (mg/L**	**Load (Tons)**	**O&M Cost (per acre-ft)**	**Capital Cost (per acre-ft)**	**Tot. Capital Cost**	**Annual Capital Costs[1]**	**Annual O&M Cost**	**Total Annual Costs**
Grassland Subsurface Drainage	Tile Drainage Re-circulation	**22** 15 % Vol. Reduction ↓	3,400	101,691	$50	$250	$5,500,000	$479,515	$1,100,000	$1,579,515
	Drainage Re-use	**19** 47 % Vol. Reduction ↓	4,000	101,691	$200	$938	$17,540,600	$1,529,269	$3,740,000	$5,269,269
	Evaporation Ponds	**10** 100 % Vol. Reduction ↓	7,547	101,691	$50	$340	$3,369,740	$293,789	$495,550	$789,339
	Landfill Disposal (cost per ton)	0	n/a	101,691	$25	$200	$20,338,120	$1,773,170	$2,542,265	$4,315,435
	Grassland Subsurface Drainage Critical Year Subtotal									**$11,953,559**
Grassland Surface Drainage	Surface Drainage Re-circulation	**60** 100 % Vol. Reduction	630	51,389	$55	$812	$48,720,000	$4,247,632	$3,300,000	$7,547,632
	Grassland Surface Drainage Critical Year Subtotal									**$7,547,632**
Wetland	Wetland Drainage Re-circulation	**132** 15 % Vol. Reduction ↓	1,000	179,454	$50	$250	$33,000,000	$2,877,090	$6,600,000	$9,477,090
	Evaporation Ponds	**112** 100 % Vol. Reduction ↓	1,176	179,454	$50	$340	$38,148,000	$3,325,916	$5,610,000	$8,935,916
	Landfill Disposal (cost per ton)	0	n/a	179,454	$25	$200	$35,890,800	$3,129,123	$4,486,350	$7,615,473
	Wetland Critical Year Subtotal									**$26,028,480**
Non-Grassland Subsurface Drainage	Tile Drainage Re-circulation	**10** 15 % Vol. Reduction ↓	1,700	23,112	$50	$250	$2,500,000	$217,961	$500,000	$717,961
	Drainage Re-use	**9** 47 % Vol. Reduction ↓	2,000	23,112	$200	$938	$7,973,000	$695,122	$1,700,000	$2,395,122
	Evaporation Ponds	**5** 100 % Vol. Reduction ↓	3,774	23,112	$50	$340	$1,531,700	$133,541	$225,250	$358,791
	Landfill Disposal (cost per ton)	**0**	n/a	23,112	$25	$200	$4,622,300	$402,993	$577,788	$980,781
	Non-Grassland Subsurface Drainage Critical Year Subtotal									**$4,452,655**
Non-Grassland Surface Drainage	Surface Drainage Re-circulation	**270** 100 % Vol. Reduction	390	143,155	$55	$812	$219,240,000	$19,114,342	$14,850,000	$33,964,342
	Non-Grassland Surface Drainage Critical Year Subtotal									**$33,964,342**

1=amortized over 20-years at 6% annual interest rate

Critical Year Annual Total Estimated Costs for Alternative 2-Prohibition of Discharge **$83,946,668**

Attachment 1 - Calculation of Cost Estimates

Alternative 3-Base Load TMDL Wet Year										
Drainage Source	**Management Practice**	**Drainage Volume (TAF)**	**Conc. (mg/L**	**Load (Tons)**	**O&M Cost (per acre-ft)**	**Capital Cost (per acre-ft)**	**Tot. Capital Cost**	**Annual Capital Costs[1]**	**Annual O&M Cost**	**Total Annual Costs**
Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**17** 15 % Vol. Reduction ↓	3,300	76,268	$50	$250	$4,250,000	$370,534	$850,000	$1,220,534
	Drainage Re-use	**14** 47 % Vol. Reduction ↓	3,882	76,268	$200	$938	$13,554,100	$1,181,708	$2,890,000	$4,071,708
	Evaporation Ponds	**8** 100 % Vol. Reduction ↓	7,325	76,268	$50	$340	$2,603,890	$227,019	$382,925	$609,944
	Landfill Disposal (cost per ton)	0	n/a	76,268	$25	$200	$15,253,590	$1,329,877	$1,906,699	$3,236,576
									Grassland Subsurface Drainage Wet Year Subtotal	**$9,138,763**
Grassland Surface Drainage	Surface Drainage Re-circulation	**29** 100 % Vol. Reduction	460	18,136	$55	$812	$23,548,000	$2,053,022	$1,595,000	$3,648,022
									Grassland Surface Drainage Wet Year Subtotal	**$3,648,022**
Wetland	Wetland Drainage Re-circulation	**9** 15 % Vol. ↓	1,000	12,236	$50	$250	$2,250,000	$196,165	$450,000	$646,165
	Evaporation Ponds	**8** 100 % Vol. Reduction ↓	1,176	12,236	$50	$340	$2,601,000	$226,767	$382,500	$609,267
	Landfill Disposal (cost per ton)	0	n/a	12,236	$25	$200	$2,447,100	$213,349	$305,888	$519,237
									Wetland Wet Year Subtotal	**$1,774,669**
Non-Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**4** 15 % Vol. Reduction ↓	1,600	8,701	$50	$250	$1,000,000	$87,185	$200,000	$287,185
	Drainage Re-use	**3** 47 % Vol. Reduction ↓	1,882	8,701	$200	$938	$3,189,200	$278,049	$680,000	$958,049
	Evaporation Ponds	**2** 100 % Vol. Reduction ↓	3,552	8,701	$50	$340	$612,680	$53,416	$90,100	$143,516
	Landfill Disposal (cost per ton)	**0**	n/a	8,701	$25	$200	$1,740,160	$151,715	$217,520	$369,235
									Non-Grassland Subsurface Drainage Wet Year Subtotal	**$1,757,985**
Non-Grassland Surface Drainage	Surface Drainage Re-circulation	**121** 100 % Vol. Reduction	390	64,155	$55	$812	$98,252,000	$8,566,057	$6,655,000	$15,221,057
									Non-Grassland Surface Drainage Wet Year Subtotal	**$15,221,057**

1=amortized over 20-years at 6% annual interest rate

Wet Year Annual Total Estimated Costs for Alternative 3-Base Load TMDL **$31,540,496**

Attachment 1 - Calculation of Cost Estimates

Alternative 3-Base Load TMDL Above Normal Year										
Drainage Source	**Management Practice**	**Drainage Volume (TAF)**	**Conc. (mg/L**	**Load (Tons)**	**O&M Cost (per acre-ft)**	**Capital Cost (per acre-ft)**	**Tot. Capital Cost**	**Annual Capital Costs[1]**	**Annual O&M Cost**	**Total Annual Costs**
Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**13** 15 % Vol. Reduction ↓	3,400	60,090	$50	$250	$3,250,000	$283,350	$650,000	$933,350
	Drainage Re-use	**11** 47 % Vol. Reduction ↓	4,000	60,090	$200	$938	$10,364,900	$903,659	$2,210,000	$3,113,659
	Evaporation Ponds	**6** 100 % Vol. Reduction ↓	7,547	60,090	$50	$340	$1,991,210	$173,603	$292,825	$466,428
	Landfill Disposal (cost per ton)	0	n/a	60,090	$25	$200	$12,017,980	$1,047,782	$1,502,248	$2,550,030
	Grassland Subsurface Drainage Above Normal Year Subtotal									**$7,063,467**
Grassland Surface Drainage	Surface Drainage Re-circulation	**29** 100 % Vol. Reduction	460	18,136	$55	$812	$23,548,000	$2,053,022	$1,595,000	$3,648,022
	Grassland Surface Drainage Above Normal Year Subtotal									**$3,648,022**
Wetland	Wetland Drainage Re-circulation	**9** 15 % Vol. ↓	1,000	12,236	$50	$250	$2,250,000	$196,165	$450,000	$646,165
	Evaporation Ponds	**8** 100 % Vol. Reduction ↓	1,176	12,236	$50	$340	$2,601,000	$226,767	$382,500	$609,267
	Landfill Disposal (cost per ton)	0	n/a	12,236	$25	$200	$2,447,100	$213,349	$305,888	$519,237
	Wetland Above Normal Year Subtotal									**$1,774,669**
Non-Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**4** 15 % Vol. Reduction ↓	1,600	8,701	$50	$250	$1,000,000	$87,185	$200,000	$287,185
	Drainage Re-use	**3** 47 % Vol. Reduction ↓	1,882	8,701	$200	$938	$3,189,200	$278,049	$680,000	$958,049
	Evaporation Ponds	**2** 100 % Vol. Reduction ↓	3,552	8,701	$50	$340	$612,680	$53,416	$90,100	$143,516
	Landfill Disposal (cost per ton)	**0**	n/a	8,701	$25	$200	$1,740,160	$151,715	$217,520	$369,235
	Non-Grassland Subsurface Drainage Above Normal Year Subtotal									**$1,757,985**
Non-Grassland Surface Drainage	Surface Drainage Re-circulation	**130** 100 % Vol. Reduction	390	68,927	$55	$812	$105,560,000	$9,203,202	$7,150,000	$16,353,202
	Non-Grassland Surface Drainage Above Normal Year Subtotal									**$16,353,202**

1=amortized over 20-years at 6% annual interest rate

Above Normal Year Annual Total Estimated Costs for Alternative 3-Base Load TMDL **$30,597,344**

Attachment 1 - Calculation of Cost Estimates

Alternative 3-Base Load TMDL Below Normal Year										
Drainage Source	Management Practice	Drainage Volume (TAF)	Conc. (mg/L	Load (Tons)	O&M Cost (per acre-ft)	Capital Cost (per acre-ft)	Tot. Capital Cost	Annual Capital Costs[1]	Annual O&M Cost	Total Annual Costs
Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**24** 15 % Vol. Reduction ↓	3,400	110,935	$50	$250	$6,000,000	$523,107	$1,200,000	$1,723,107
	Drainage Re-use	**20** 47 % Vol. Reduction ↓	4,000	110,935	$200	$938	$19,135,200	$1,668,294	$4,080,000	$5,748,294
	Evaporation Ponds	**11** 100 % Vol. Reduction ↓	7,547	110,935	$50	$340	$3,676,080	$320,497	$540,600	$861,097
	Landfill Disposal (cost per ton)	0	n/a	110,935	$25	$200	$22,187,040	$1,934,367	$2,773,380	$4,707,747
	Grassland Subsurface Drainage Below Normal Year Subtotal									**$13,040,246**
Grassland Surface Drainage	Surface Drainage Re-circulation	**40** 100 % Vol. Reduction	601	32,682	$55	$812	$32,480,000	$2,831,754	$2,200,000	$5,031,754
	Grassland Surface Drainage Below Normal Year Subtotal									**$5,031,754**
Wetland	Wetland Drainage Re-circulation	**43** 15 % Vol. ↓	1,000	58,459	$50	$250	$10,750,000	$937,234	$2,150,000	$3,087,234
	Evaporation Ponds	**37** 100 % Vol. Reduction ↓	1,176	58,459	$50	$340	$12,427,000	$1,083,442	$1,827,500	$2,910,942
	Landfill Disposal (cost per ton)	0	n/a	58,459	$25	$200	$11,691,700	$1,019,336	$1,461,463	$2,480,798
	Wetland Below Normal Year Subtotal									**$8,478,975**
Non-Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**7** 15 % Vol. Reduction ↓	1,600	15,226	$50	$250	$1,750,000	$152,573	$350,000	$502,573
	Drainage Re-use	**6** 47 % Vol. Reduction ↓	1,882	15,226	$200	$938	$5,581,100	$486,586	$1,190,000	$1,676,586
	Evaporation Ponds	**3** 100 % Vol. Reduction ↓	3,552	15,226	$50	$340	$1,072,190	$93,478	$157,675	$251,153
	Landfill Disposal (cost per ton)	**0**	n/a	15,226	$25	$200	$3,045,280	$265,501	$380,660	$646,161
	Non-Grassland Subsurface Drainage Below Normal Year Subtotal									**$3,076,474**
Non-Grassland Surface Drainage	Surface Drainage Re-circulation	**130** 100 % Vol. Reduction	390	68,927	$55	$812	$105,560,000	$9,203,202	$7,150,000	$16,353,202
	Non-Grassland Surface Drainage Below Normal Year Subtotal									**$16,353,202**

1=amortized over 20-years at 6% annual interest rate

Below Normal Year Annual Total Estimated Costs for Alternative 3-Base Load TMDL **$45,980,650**

Attachment 1 - Calculation of Cost Estimates

Alternative 3-Base Load TMDL Dry Year										
Drainage Source	Management Practice	Drainage Volume (TAF)	Conc. (mg/L	Load (Tons)	O&M Cost (per acre-ft)	Capital Cost (per acre-ft)	Tot. Capital Cost	Annual Capital Costs[1]	Annual O&M Cost	Total Annual Costs
Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**23** 15 % Vol. Reduction ↓	3,400	106,313	$50	$250	$5,750,000	$501,311	$1,150,000	$1,651,311
	Drainage Re-use	**20** 47 % Vol. Reduction ↓	4,000	106,313	$200	$938	$18,337,900	$1,598,782	$3,910,000	$5,508,782
	Evaporation Ponds	**10** 100 % Vol. Reduction ↓	7,547	106,313	$50	$340	$3,522,910	$307,143	$518,075	$825,218
	Landfill Disposal (cost per ton)	0	n/a	106,313	$25	$200	$21,262,580	$1,853,769	$2,657,823	$4,511,591
	Grassland Subsurface Drainage Dry Year Subtotal									**$12,496,902**
Grassland Surface Drainage	Surface Drainage Re-circulation	**48** 100 % Vol. Reduction	650	42,416	$55	$812	$38,976,000	$3,398,105	$2,640,000	$6,038,105
	Grassland Surface Drainage Dry Year Subtotal									**$6,038,105**
Wetland	Wetland Drainage Re-circulation	**47** 15 % Vol. Reduction ↓	1,000	63,897	$50	$250	$11,750,000	$1,024,419	$2,350,000	$3,374,419
	Evaporation Ponds	**40** 100 % Vol. Reduction ↓	1,176	63,897	$50	$340	$13,583,000	$1,184,228	$1,997,500	$3,181,728
	Landfill Disposal (cost per ton)	0	n/a	63,897	$25	$200	$12,779,300	$1,114,158	$1,597,413	$2,711,570
	Wetland Dry Year Subtotal									**$9,267,716**
Non-Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**7** 15 % Vol. Reduction ↓	1,600	15,226	$50	$250	$1,750,000	$152,573	$350,000	$502,573
	Drainage Re-use	**6** 47 % Vol. Reduction ↓	1,882	15,226	$200	$938	$5,581,100	$486,586	$1,190,000	$1,676,586
	Evaporation Ponds	**3** 100 % Vol. Reduction ↓	3,552	15,226	$50	$340	$1,072,190	$93,478	$157,675	$251,153
	Landfill Disposal (cost per ton)	**0**	n/a	15,226	$25	$200	$3,045,280	$265,501	$380,660	$646,161
	Non-Grassland Subsurface Drainage Dry Year Subtotal									**$3,076,474**
Non-Grassland Surface Drainage	Surface Drainage Re-circulation	**147** 100 % Vol. Reduction	380	75,942	$55	$812	$119,364,000	$10,406,697	$8,085,000	$18,491,697
	Non-Grassland Surface Drainage Dry Year Subtotal									**$18,491,697**

1=amortized over 20-years at 6% annual interest rate

Dry Year Annual Total Estimated Costs for Alternative 3-Base Load TMDL **$49,370,895**

Attachment 1 - Calculation of Cost Estimates

Alternative 3-Base Load TMDL Critical Year										
Drainage Source	**Management Practice**	**Drainage Volume (TAF)**	**Conc. (mg/L**	**Load (Tons)**	**O&M Cost (per acre-ft)**	**Capital Cost (per acre-ft)**	**Tot. Capital Cost**	**Annual Capital Costs[1]**	**Annual O&M Cost**	**Total Annual Costs**
Grassland subsurface Drainage	Subsurface Drainage Re-circulation	**21** 15 % Vol. Reduction ↓	3,400	97,068	$50	$250	$5,250,000	$457,719	$1,050,000	$1,507,719
	Drainage Re-use	**18** 47 % Vol. Reduction ↓	4,000	97,068	$200	$938	$16,743,300	$1,459,757	$3,570,000	$5,029,757
	Evaporation Ponds	**9** 100 % Vol. Reduction ↓	7,547	97,068	$50	$340	$3,216,570	$280,435	$473,025	$753,460
	Landfill Disposal (cost per ton)	0	n/a	97,068	$25	$200	$19,413,660	$1,692,571	$2,426,708	$4,119,279
	Grassland Subsurface Drainage Critical Year Subtotal									**$11,410,215**
Grassland Surface Drainage	Surface Drainage Re-circulation	**53** 100 % Vol. Reduction	640	46,114	$55	$812	$43,036,000	$3,752,075	$2,915,000	$6,667,075
	Grassland Surface Drainage Critical Year Subtotal									**$6,667,075**
Wetland	Wetland Drainage Re-circulation	**77** 15 % Vol. Reduction ↓	1,000	104,682	$50	$250	$19,250,000	$1,678,303	$3,850,000	$5,528,303
	Evaporation Ponds	**65** 100 % Vol. Reduction ↓	1,176	104,682	$50	$340	$22,253,000	$1,940,118	$3,272,500	$5,212,618
	Landfill Disposal (cost per ton)	0	n/a	104,682	$25	$200	$20,936,300	$1,825,322	$2,617,038	$4,442,360
	Wetland Critical Year Subtotal									**$15,183,280**
Non-Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**9** 15 % Vol. Reduction ↓	1,700	20,800	$50	$250	$2,250,000	$196,165	$450,000	$646,165
	Drainage Re-use	**8** 47 % Vol. Reduction ↓	2,000	20,800	$200	$938	$7,175,700	$625,610	$1,530,000	$2,155,610
	Evaporation Ponds	**4** 100 % Vol. Reduction ↓	3,774	20,800	$50	$340	$1,378,530	$120,187	$202,725	$322,912
	Landfill Disposal (cost per ton)	**0**	n/a	20,800	$25	$200	$4,160,070	$362,694	$520,009	$882,703
	Non-Grassland Subsurface Drainage Critical Year Subtotal									**$4,007,390**
Non-Grassland Surface Drainage	Surface Drainage Re-circulation	**204** 100 % Vol. Reduction	380	105,388	$55	$812	$165,648,000	$14,441,947	$11,220,000	$25,661,947
	Non-Grassland Surface Drainage Critical Year Subtotal									**$25,661,947**

1=amortized over 20-years at 6% annual interest rate

Critical Year Annual Total Estimated Costs for Alternative 3-Base Load TMDL **$62,929,907**

Attachment 1 - Calculation of Cost Estimates

Alternative 4a-Real-time TMDL Wet Year										
Drainage Source	**Management Practice**	**Drainage Volume (TAF)**	**Conc. (mg/L**	**Load (Tons)**	**O&M Cost (per acre-ft)**	**Capital Cost (per acre-ft)**	**Tot. Capital Cost**	**Annual Capital Costs[1]**	**Annual O&M Cost**	**Total Annual Costs**
Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**9** 15 % Vol. Reduction ↓	3,400	41,601	$50	$250	$2,250,000	$196,165	$450,000	$646,165
	Drainage Re-use	**8** 47 % Vol. Reduction ↓	4,000	41,601	$200	$938	$7,175,700	$625,610	$1,530,000	$2,155,610
	Evaporation Ponds	**4** 100 % Vol. Reduction ↓	7,547	41,601	$50	$340	$1,378,530	$120,187	$202,725	$322,912
	Landfill Disposal (cost per ton)	0	n/a	41,601	$25	$200	$8,320,140	$725,388	$1,040,018	$1,765,405
	Grassland Subsurface Drainage Wet Year Subtotal									**$4,890,092**
Grassland Surface Drainage	Surface Drainage Re-circulation	**0** 100 % Vol. Reduction	n/a	n/a	$55	$812	$0	$0	$0	$0
	Grassland Surface Drainage Wet Year Subtotal									**$0**
Wetland	Wetland Drainage Re-circulation	**0** 15 % Vol. ↓	n/a	n/a	$50	$250	$0	$0	$0	$0
	Evaporation Ponds	**0** 100 % Vol. Reduction ↓	n/a	n/a	$50	$340	$0	$0	$0	$0
	Landfill Disposal (cost per ton)	0	n/a	n/a	$25	$200	$0	$0	$0	$0
	Wetland Wet Year Subtotal									**$0**
Non-Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**0** 15 % Vol. Reduction ↓	n/a	n/a	$50	$250	$0	$0	$0	$0
	Drainage Re-use	**0** 47 % Vol. Reduction ↓	n/a	n/a	$200	$938	$0	$0	$0	$0
	Evaporation Ponds	**0** 100 % Vol. Reduction ↓	n/a	n/a	$50	$340	$0	$0	$0	$0
	Landfill Disposal (cost per ton)	**0**	n/a	n/a	$25	$200	$0	$0	$0	$0
	Non-Grassland Subsurface Drainage Wet Year Subtotal									**$0**
Non-Grassland Surface Drainage	Surface Drainage Re-circulation	**0** 100 % Vol. Reduction	n/a	n/s	$55	$812	$0	$0	$0	$0
	Non-Grassland Surface Drainage Wet Year Subtotal									**$4,890,092**
Real-time Management costs	**11 Real-time management systems x $350,000 per system + $100,000 O&M per system =**									**$1,435,661**

1=amortized over 20-years at 6% annual interest rate

Wet Year Annual Total Estimated Costs for Alternative 4a-Real-time TMDL **$6,325,753**

Attachment 1 - Calculation of Cost Estimates

Alternative 4a-Real-time TMDL Above Normal Year

Drainage Source	Management Practice	Drainage Volume (TAF)	Conc. (mg/L	Load (Tons)	O&M Cost (per acre-ft)	Capital Cost (per acre-ft)	Tot. Capital Cost	Annual Capital Costs[1]	Annual O&M Cost	Total Annual Costs
Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**8** 15 % Vol. Reduction ↓	3,400	36,978	$50	$250	$2,000,000	$174,369	$400,000	$574,369
	Drainage Re-use	**7** 47 % Vol. Reduction ↓	4,000	36,978	$200	$938	$6,378,400	$556,098	$1,360,000	$1,916,098
	Evaporation Ponds	**4** 100 % Vol. Reduction ↓	7,547	36,978	$50	$340	$1,225,360	$106,832	$180,200	$287,032
	Landfill Disposal (cost per ton)	0	n/a	36,978	$25	$200	$7,395,680	$644,789	$924,460	$1,569,249
	Grassland Subsurface Drainage Above Normal Year Subtotal									**$4,346,749**
Grassland Surface Drainage	Surface Drainage Re-circulation	**2** 100 % Vol. Reduction	430	1,169	$55	$812	$1,624,000	$141,588	$110,000	$251,588
	Grassland Surface Drainage Above Normal Year Subtotal									**$251,588**
Wetland	Wetland Drainage Re-circulation	**14** 15 % Vol. ↓	1,000	19,033	$50	$250	$3,500,000	$305,146	$700,000	$1,005,146
	Evaporation Ponds	**12** 100 % Vol. Reduction ↓	1,176	19,033	$50	$340	$4,046,000	$352,749	$595,000	$947,749
	Landfill Disposal (cost per ton)	0	n/a	19,033	$25	$200	$3,806,600	$331,877	$475,825	$807,702
	Wetland Above Normal Year Subtotal									**$2,760,596**
Non-Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**1** 15 % Vol. Reduction ↓	1,500	2,039	$50	$250	$250,000	$21,796	$50,000	$71,796
	Drainage Re-use	**1** 47 % Vol. Reduction ↓	1,765	2,039	$200	$938	$797,300	$69,512	$170,000	$239,512
	Evaporation Ponds	**0** 100 % Vol. Reduction ↓	3,330	2,039	$50	$340	$153,170	$13,354	$22,525	$35,879
	Landfill Disposal (cost per ton)	**0**	n/a	2,039	$25	$200	$407,850	$35,558	$50,981	$86,539
	Non-Grassland Subsurface Drainage Above Normal Year Subtotal									**$433,727**
Non-Grassland Surface Drainage	Surface Drainage Re-circulation	**0** 100 % Vol. Reduction	n/a	n/a	$55	$812	$0	$0	$0	$0
	Non-Grassland Surface Drainage Above Normal Year Subtotal									**$0**
Real-time Management costs		**11 Real-time management systems x $350,000 per system + $100,000 O&M per system**						**=**		**$1,435,661**

1=amortized over 20-years at 6% annual interest rate

Above Normal Year Annual Total Estimated Costs for Alternative 4a-Real-time TMDL **$9,228,320**

Attachment 1 - Calculation of Cost Estimates

Alternative 4a-Real-time TMDL Below Normal Year										
Drainage Source	Management Practice	Drainage Volume (TAF)	Conc. (mg/L	Load (Tons)	O&M Cost (per acre-ft)	Capital Cost (per acre-ft)	Tot. Capital Cost	Annual Capital Costs[1]	Annual O&M Cost	Total Annual Costs
Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**18** 15 % Vol. Reduction ↓	3,500	85,649	$50	$250	$4,500,000	$392,331	$900,000	$1,292,331
	Drainage Re-use	**15** 47 % Vol. Reduction ↓	4,118	85,649	$200	$938	$14,351,400	$1,251,220	$3,060,000	$4,311,220
	Evaporation Ponds	**8** 100 % Vol. Reduction ↓	7,769	85,649	$50	$340	$2,757,060	$240,373	$405,450	$645,823
	Landfill Disposal (cost per ton)	0	n/a	85,649	$25	$200	$17,129,700	$1,493,445	$2,141,213	$3,634,658
	Grassland Subsurface Drainage Below Normal Year Subtotal									**$9,884,032**
Grassland Surface Drainage	Surface Drainage Re-circulation	**10** 100 % Vol. Reduction	640	8,701	$55	$812	$8,120,000	$707,939	$550,000	$1,257,939
	Grassland Surface Drainage Below Normal Year Subtotal									**$1,257,939**
Wetland	Wetland Drainage Re-circulation	**9** 15 % Vol. ↓	1,000	12,236	$50	$250	$2,250,000	$196,165	$450,000	$646,165
	Evaporation Ponds	**8** 100 % Vol. Reduction ↓	1,176	12,236	$50	$340	$2,601,000	$226,767	$382,500	$609,267
	Landfill Disposal (cost per ton)	0	n/a	12,236	$25	$200	$2,447,100	$213,349	$305,888	$519,237
	Wetland Below Normal Year Subtotal									**$1,774,669**
Non-Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**3** 15 % Vol. Reduction ↓	1,700	6,933	$50	$250	$750,000	$65,388	$150,000	$215,388
	Drainage Re-use	**3** 47 % Vol. Reduction ↓	2,000	6,933	$200	$938	$2,391,900	$208,537	$510,000	$718,537
	Evaporation Ponds	**1** 100 % Vol. Reduction ↓	3,774	6,933	$50	$340	$459,510	$40,062	$67,575	$107,637
	Landfill Disposal (cost per ton)	**0**	n/a	6,933	$25	$200	$1,386,690	$120,898	$173,336	$294,234
	Non-Grassland Subsurface Drainage Below Normal Year Subtotal									**$1,335,797**
Non-Grassland Surface Drainage	Surface Drainage Re-circulation	**6** 100 % Vol. Reduction	370	3,018	$55	$812	$4,872,000	$424,763	$330,000	$754,763
	Non-Grassland Surface Drainage Below Normal Year Subtotal									**$754,763**
Real-time Management costs		**11 Real-time management systems x $350,000 per system + $100,000 O&M per system =**								**$1,435,661**

1=amortized over 20-years at 6% annual interest rate

Below Normal Year Annual Total Estimated Costs for Alternative 4a-Real-time TMDL $16,442,860

Attachment 1 - Calculation of Cost Estimates

Alternative 4a-Real-time TMDL Dry Year										
Drainage Source	**Management Practice**	**Drainage Volume (TAF)**	**Conc. (mg/L**	**Load (Tons)**	**O&M Cost (per acre-ft)**	**Capital Cost (per acre-ft)**	**Tot. Capital Cost**	**Annual Capital Costs[1]**	**Annual O&M Cost**	**Total Annual Costs**
Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**17** 15 % Vol. Reduction ↓	3,500	80,890	$50	$250	$4,250,000	$370,534	$850,000	$1,220,534
	Drainage Re-use	**14** 47 % Vol. Reduction ↓	4,118	80,890	$200	$938	$13,554,100	$1,181,708	$2,890,000	$4,071,708
	Evaporation Ponds	**8** 100 % Vol. Reduction ↓	7,769	80,890	$50	$340	$2,603,890	$227,019	$382,925	$609,944
	Landfill Disposal (cost per ton)	0	n/a	80,890	$25	$200	$16,178,050	$1,410,476	$2,022,256	$3,432,732
	Grassland Subsurface Drainage Dry Year Subtotal									**$9,334,919**
Grassland Surface Drainage	Surface Drainage Re-circulation	**13** 100 % Vol. Reduction	670	11,841	$55	$812	$10,556,000	$920,320	$715,000	$1,635,320
	Grassland Surface Drainage Dry Year Subtotal									**$1,635,320**
Wetland	Wetland Drainage Re-circulation	**17** 15 % Vol. Reduction ↓	1,000	23,112	$50	$250	$4,250,000	$370,534	$850,000	$1,220,534
	Evaporation Ponds	**14** 100 % Vol. Reduction ↓	1,176	23,112	$50	$340	$4,913,000	$428,338	$722,500	$1,150,838
	Landfill Disposal (cost per ton)	0	n/a	23,112	$25	$200	$4,622,300	$402,993	$577,788	$980,781
	Wetland Dry Year Subtotal									**$3,352,153**
Non-Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**3** 15 % Vol. Reduction ↓	1,700	6,933	$50	$250	$750,000	$65,388	$150,000	$215,388
	Drainage Re-use	**3** 47 % Vol. Reduction ↓	2,000	6,933	$200	$938	$2,391,900	$208,537	$510,000	$718,537
	Evaporation Ponds	**1** 100 % Vol. Reduction ↓	3,774	6,933	$50	$340	$459,510	$40,062	$67,575	$107,637
	Landfill Disposal (cost per ton)	**0**	n/a	6,933	$25	$200	$1,386,690	$120,898	$173,336	$294,234
	Non-Grassland Subsurface Drainage Dry Year Subtotal									**$1,335,797**
Non-Grassland Surface Drainage	Surface Drainage Re-circulation	**2** 100 % Vol. Reduction	400	1,088	$55	$812	$1,624,000	$141,588	$110,000	$251,588
	Non-Grassland Surface Drainage Dry Year Subtotal									**$251,588**
Real-time Management costs		**11 Real-time management systems x $350,000 per system + $100,000 O&M per system**						**=**		**$1,435,661**

1=amortized over 20-years at 6% annual interest rate

Dry Year Annual Total Estimated Costs for Alternative 4a-Real-time TMDL **$17,345,437**

Attachment 1 - Calculation of Cost Estimates

Drainage Source	Management Practice	Drainage Volume (TAF)	Conc. (mg/L	Load (Tons)	O&M Cost (per acre-ft)	Capital Cost (per acre-ft)	Tot. Capital Cost	Annual Capital Costs[1]	Annual O&M Cost	Total Annual Costs
Alternative 4a-Real-time TMDL Critical Year										
Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**18** 15 % Vol. Reduction ↓	3,400	83,201	$50	$250	$4,500,000	$392,331	$900,000	$1,292,331
	Drainage Re-use	**15** 47 % Vol. Reduction ↓	4,000	83,201	$200	$938	$14,351,400	$1,251,220	$3,060,000	$4,311,220
	Evaporation Ponds	**8** 100 % Vol. Reduction ↓	7,547	83,201	$50	$340	$2,757,060	$240,373	$405,450	$645,823
	Landfill Disposal (cost per ton)	0	n/a	83,201	$25	$200	$16,640,280	$1,450,775	$2,080,035	$3,530,810
	Grassland Subsurface Drainage Critical Year Subtotal									**$9,780,184**
Grassland Surface Drainage	Surface Drainage Re-circulation	**30** 100 % Vol. Reduction	570	23,247	$55	$812	$24,360,000	$2,123,816	$1,650,000	$3,773,816
	Grassland Surface Drainage Critical Year Subtotal									**$3,773,816**
Wetland	Wetland Drainage Re-circulation	**31** 15 % Vol. Reduction ↓	1,000	42,145	$50	$250	$7,750,000	$675,680	$1,550,000	$2,225,680
	Evaporation Ponds	**26** 100 % Vol. Reduction ↓	1,176	42,145	$50	$340	$8,959,000	$781,086	$1,317,500	$2,098,586
	Landfill Disposal (cost per ton)	0	n/a	42,145	$25	$200	$8,428,900	$734,870	$1,053,613	$1,788,482
	Wetland Critical Year Subtotal									**$6,112,749**
Non-Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**5** 15 % Vol. Reduction ↓	1,700	11,556	$50	$250	$1,250,000	$108,981	$250,000	$358,981
	Drainage Re-use	**4** 47 % Vol. Reduction ↓	2,000	11,556	$200	$938	$3,986,500	$347,561	$850,000	$1,197,561
	Evaporation Ponds	**2** 100 % Vol. Reduction ↓	3,774	11,556	$50	$340	$765,850	$66,770	$112,625	$179,395
	Landfill Disposal (cost per ton)	**0**	n/a	11,556	$25	$200	$2,311,150	$201,497	$288,894	$490,390
	Non-Grassland Subsurface Drainage Critical Year Subtotal									**$2,226,328**
Non-Grassland Surface Drainage	Surface Drainage Re-circulation	**34** 100 % Vol. Reduction	380	17,565	$55	$812	$27,608,000	$2,406,991	$1,870,000	$4,276,991
	11 Real-time management systems x $350,000 per system + $100,000 O&M per system =									**$4,276,991**
Real-time Management costs	**11 Real-time management systems at $350,000 per system + $100,000 O&M per system =**									**$1,435,661**

1=amortized over 20-years at 6% annual interest rate

Critical Year Annual Total Estimated Costs for Alternative 4a-Real-time TMDL **$27,605,729**

Attachment 1 - Calculation of Cost Estimates

Alternative 4b-Real-time TMDL w/ Drainage Re-operation Wet Year										
Drainage Source	**Management Practice**	**Drainage Volume (TAF)**	**Conc. (mg/L**	**Load (Tons)**	**O&M Cost (per acre-ft)**	**Capital Cost (per acre-ft)**	**Tot. Capital Cost**	**Annual Capital Costs[1]**	**Annual O&M Cost**	**Total Annual Costs**
Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**9** 15 % Vol. Reduction ↓	3,400	41,601	$50	$250	$2,250,000	$196,165	$450,000	$646,165
	Drainage Re-use	**8** 47 % Vol. Reduction ↓	4,000	41,601	$200	$938	$7,175,700	$625,610	$1,530,000	$2,155,610
	Evaporation Ponds	**4** 100 % Vol. Reduction ↓	7,547	41,601	$50	$340	$1,378,530	$120,187	$202,725	$322,912
	Landfill Disposal (cost per ton)	0	n/a	41,601	$25	$200	$8,320,140	$725,388	$1,040,018	$1,765,405
	Grassland Subsurface Drainage Wet Year Subtotal									**$4,890,092**
Drainage Re-operation		**50** 100 % Vol. Reduction	n/a	n/a	50	315	$15,750,000	$1,373,157	$2,500,000	**$3,873,157**
Real-time Management costs	**11 Real-time management systems x $350,000 per system + $100,000 O&M per system**							**=**		**$1,435,661**

1=amortized over 20-years at 6% annual interest rate

Wet Year Annual Total Estimated Costs for Alternative 4b-Real-time TMDL w/ Drainage Re-operation **$10,198,910**

Attachment 1 - Calculation of Cost Estimates

Alternative 4b-Real-time TMDL w/ Drainage Re-operation Above Normal Year										
Drainage Source	Management Practice	Drainage Volume (TAF)	Conc. (mg/L	Load (Tons)	O&M Cost (per acre-ft)	Capital Cost (per acre-ft)	Tot. Capital Cost	Annual Capital Costs[1]	Annual O&M Cost	Total Annual Costs
Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**8** 15 % Vol. Reduction ↓	3,400	36,978	$50	$250	$2,000,000	$174,369	$400,000	$574,369
	Drainage Re-use	**7** 47 % Vol. Reduction ↓	4,000	36,978	$200	$938	$6,378,400	$556,098	$1,360,000	$1,916,098
	Evaporation Ponds	**4** 100 % Vol. Reduction ↓	7,547	36,978	$50	$340	$1,225,360	$106,832	$180,200	$287,032
	Landfill Disposal (cost per ton)	0	n/a	36,978	$25	$200	$7,395,680	$644,789	$924,460	$1,569,249
	Grassland Subsurface Drainage Wet Year Subtotal									**$4,346,749**
Drainage Re-operation		**50** 100 % Vol. Reduction	n/a	n/a	50	315	$15,750,000	$1,373,157	$2,500,000	**$3,873,157**
Real-time Management costs	**11 Real-time management systems x $350,000 per system + $100,000 O&M per system =**									**$1,435,661**

1=amortized over 20-years at 6% annual interest rate

Above Normal Year Annual Total Estimated Costs for Alternative 4b-Real-time TMDL w/ Drainage Re-operation **$9,655,566**

Attachment 1 - Calculation of Cost Estimates

Alternative 4b-Real-time TMDL Drainage w/ Re-operation Below Normal Year										
Drainage Source	**Management Practice**	**Drainage Volume (TAF)**	**Conc. (mg/L**	**Load (Tons)**	**O&M Cost (per acre-ft)**	**Capital Cost (per acre-ft)**	**Tot. Capital Cost**	**Annual Capital Costs[1]**	**Annual O&M Cost**	**Total Annual Costs**
Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**18** 15 % Vol. Reduction ↓	3,500	85,649	$50	$250	$4,500,000	$392,331	$900,000	$1,292,331
	Drainage Re-use	**15** 47 % Vol. Reduction ↓	4,118	85,649	$200	$938	$14,351,400	$1,251,220	$3,060,000	$4,311,220
	Evaporation Ponds	**8** 100 % Vol. Reduction ↓	7,769	85,649	$50	$340	$2,757,060	$240,373	$405,450	$645,823
	Landfill Disposal (cost per ton)	0	n/a	85,649	$25	$200	$17,129,700	$1,493,445	$2,141,213	$3,634,658
	Grassland Subsurface Drainage Wet Year Subtotal									**$9,884,032**
Drainage Re-operation		**50** 100 % Vol. Reduction	n/a	n/a	50	315	$15,750,000	$1,373,157	$2,500,000	**$3,873,157**
Real-time Management costs	**11 Real-time management systems x $350,000 per system + $100,000 O&M per system**							**=**		**$1,435,661**

1=amortized over 20-years at 6% annual interest rate

Below NormalYear Annual Total Estimated Costs for Alternative 4-Real-time TMDL w/ Drainage Re-operation **$15,192,849**

Attachment 1 - Calculation of Cost Estimates

Alternative 4b-Real-time TMDL w/ Drainage Re-operation Dry Year										
Drainage Source	**Management Practice**	**Drainage Volume (TAF)**	**Conc. (mg/L**	**Load (Tons)**	**O&M Cost (per acre-ft)**	**Capital Cost (per acre-ft)**	**Tot. Capital Cost**	**Annual Capital Costs[1]**	**Annual O&M Cost**	**Total Annual Costs**
Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**9** 17 ↓	3,500	42,824	$50	$250	$2,250,000	$196,165	$450,000	$646,165
	Drainage Re-use	**8** 47 % Vol. Reduction ↓	4,118	42,824	$200	$938	$7,175,700	$625,610	$1,530,000	$2,155,610
	Evaporation Ponds	**4** 100 % Vol. Reduction ↓	7,769	42,824	$50	$340	$1,378,530	$120,187	$202,725	$322,912
	Landfill Disposal (cost per ton)	0	n/a	42,824	$25	$200	$8,564,850	$746,723	$1,070,606	$1,817,329
	Grassland Subsurface Drainage Wet Year Subtotal									**$4,942,016**
Drainage Re-operation		**50** 100 % Vol. Reduction	n/a	n/a	50	315	$15,750,000	$1,373,157	$2,500,000	**$3,873,157**
Real-time Management costs	**11 Real-time management systems x $350,000 per system + $100,000 O&M per system**							**=**		**$1,435,661**

1=amortized over 20-years at 6% annual interest rate

Dry Year Annual Total Estimated Costs for Alternative 4b-Real-time TMDL w/ Drainage Re-operation **$10,250,833**

Attachment 1 - Calculation of Cost Estimates

Alternative 4b-Real-time TMDL w/ Drainage Re-operation Critical Year										
Drainage Source	**Management Practice**	**Drainage Volume (TAF)**	**Conc. (mg/L**	**Load (Tons)**	**O&M Cost (per acre-ft)**	**Capital Cost (per acre-ft)**	**Tot. Capital Cost**	**Annual Capital Costs[1]**	**Annual O&M Cost**	**Total Annual Costs**
Grassland Subsurface Drainage	Subsurface Drainage Re-circulation	**18** 15 % Vol. Reduction ↓	3,400	83,201	$50	$250	$4,500,000	$392,331	$900,000	$1,292,331
	Drainage Re-use	**15** 47 % Vol. Reduction ↓	4,000	83,201	$200	$938	$14,351,400	$1,251,220	$3,060,000	$4,311,220
	Evaporation Ponds	**8** 100 % Vol. Reduction ↓	7,547	83,201	$50	$340	$2,757,060	$240,373	$405,450	$645,823
	Landfill Disposal (cost per ton)	0	n/a	83,201	$25	$200	$16,640,280	$1,450,775	$2,080,035	$3,530,810
	Grassland Subsurface Drainage Wet Year Subtotal									**$9,780,184**
Drainage Re-operation		**50** 100 % Vol. Reduction	n/a	n/a	50	315	$15,750,000	$1,373,157	$2,500,000	**$3,873,157**
Real-time Management costs	**11 Real-time management systems x $350,000 per system + $100,000 O&M per system**							**=**		**$1,435,661**

1=amortized over 20-years at 6% annual interest rate

Critical Year Annual Total Estimated Costs for Alternative 4b-Real-time TMDL w/ Drainage Re-operation **$15,089,002**